POWER

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ELY C. HUTCHINSON, *Editor*

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Don't Keep Good Men Down

THE JOB of an executive or an executor is to execute, to get things done.

Usually he does few of them directly, but surrounds himself with an organization by the management, inspiration and guidance of which he carries out his plans and purposes.

Andrew Carnegie said something to the effect that he owed his success to his ability to pick exceptionally able assistants to do his job for him.

It costs a lot of time and work and money to mold and break in such an organization to find the men who are adapted or adaptable to play each his allotted part, to keep them engaged with pep and vim and interest in the common task. Such an organization is the major asset of many an important business.

Supremacy depends upon having a superior personnel, a corps that can turn out better work and do it faster and more efficiently than that of a competitor.

There is therefore a natural tendency on the part of the responsible head to reach for new talent, to hunt for "comers," to not only search the best that the field develops for his own use but to keep it from his competitors.

This is often done to an extent that is disorganizing and disheartening to the members of the existing staff. The best incentive to devoted and interested effort is confidence of appreciation and hope of advancement.

The far-sighted executive, therefore, with an eye to inevitable change and future exigencies, will build a progressive and promotional rather than a static organization; will not keep a man continually upon the same job because he does it exceptionally well, but will consider whether he would not be equally effective higher up.

But he cannot do this if the man is so fixed in his present setting that he cannot qualify for the better. Advancement requires, first of all, qualification, ability to do the larger job and the breadth to invite greater responsibilities.

With a staff of workers each not lost in his own little niche but prepared to take a larger part when opportunity offers, the ordinary executive will prefer to keep them moving up, and will recognize and encourage any manifestation of a disposition to be in readiness for such advancement.

F. R. Low

EDITORIALS

In the Interest of Water Power

THE DECISION of the United States Supreme Court limiting the water diverted from Lake Michigan into Chicago's sanitary-district drainage canal, may be considered, among other things, a victory for water-power development. The controversy over the amount of water that the city may divert into its drainage system is one of over thirty-years standing. Although this diversion has not greatly exceeded ten thousand second-feet, an ultimate volume of fourteen thousand second-feet was at one time contemplated. At present the diversion amounts to about eight thousand five hundred second-feet, not including that which is used in the city's water system. The Court has ordered that a gradual decrease in the diversion be made until in 1938, when the volume shall not exceed fifteen hundred second-feet, at which time it is expected that Chicago will have completed its sewage-disposal plants.

To concede the claims of the State of Illinois and the City of Chicago is tantamount to giving them something bestowed by nature upon other states. Of the total land area in the drainage basin of Lake Michigan, about one thousand square miles, or less than two and one-half per cent, is in the State of Illinois. Assuming that Illinois had a right to divert all the water draining from its land area, Chicago would receive less than the fifteen hundred second-feet set as the low limit by the Court.

Aside from this, there is the indisputable fact that the maximum water diverted by Chicago at one time would, if utilized, produce five hundred thousand horsepower in the Niagara and St. Lawrence Rivers. At one pound of coal per horsepower-hour this power represents a coal equivalent of over two million tons per year. As the water is available continuously, it is the equal of a coal mine capable of supplying over two million tons per year for all time. This power is taken from a district in Canada and New York State that is a long distance from coal fields. If the water being diverted from Lake Michigan were available, the time is not far distant when it would be used for power. When that time comes the State of New York and the Dominion of Canada have a right to this resource, given them by nature, particularly when there are other ways for Chicago to handle her sewage. The Supreme Court decree orders that this be done, in large part, by 1938.

Stokers for Large Capacities

SOME YEARS AGO, when it was found practicable to regularly operate boilers at several times normal rating, the fuel supply problem was met in many cases by the installation of double-ended stokers. As competition from pulverized coal became a factor and boilers continued to increase in size, attention was directed to the development of the long, single-ended stoker, although a few companies continued to employ the double units. Single stokers have now been built to meet an output of over half a million pounds of steam per hour. This, however, is less than half the maximum output obtained with a single pulverized-coal-burning boiler.

There are many who believe this challenge will be met by the further development of the double stoker.

Single stokers fifty-seven tuyeres long are now in operation, and it is doubtful if this length will be much increased. Twenty retorts at present represent the maximum width. Very long stokers intensify the problem of air distribution, and bare spots on the rear sections are aggravated when preheated air is used.

Factors that weigh against the double stoker are the necessity for two firing aisles, accompanied by an additional coal bunker and increased attendance; longer tubes, if horizontal boilers are employed; and the necessity of placing economizers, perheaters and fans above the boilers, thus adding to the building height. The last arrangement, however, is already common with single stokers, hence cannot be validly advanced as an argument against the double type.

In favor of the double stoker are the reduced travel of the coal; responsiveness to varying load; elimination

of the bridge wall; the radiant heat from either fuel bed directed upon the other; and greater output per unit.

Economic factors involved in particular installations will always influence the decision, but the advocates of the double stoker appear to have much in favor of their contentions if the stoker is to compete with pulverized coal in the matter of capacity.

Architects and Boiler Plants

BOILER PLANTS in many hotels and office buildings reflect little or no attention, on the part of the architect, to the needs of the equipment. Ordinarily, only such space and location are set aside for housing the boilers as may conform to the architectural features of the building. The specific requirements of the boiler room are thrust into secondary positions. One of the common difficulties is inadequate headroom. This generally leads to the construction of furnaces of inadequate volume, which either smoke intermittently or operate inefficiently. Furthermore, maintenance on such furnaces is usually high. Cramped boiler rooms are hot and poorly ventilated, and generally lack adequate provision for handling the coal and ashes.

The architect's desire to have the chimney conform to the general style of the building frequently leads to inadequate height or insufficient area, resulting in reduced draft and also in the discharge of smoke and ash too close to the ground. At times long breechings with many bends are required to accommodate a poorly placed chimney.

Much can be gained in building construction by closer co-operation between the architect and the mechanical engineer. Reasonable consideration by each of the other's requirements will generally lead to better boiler plants free from many of the handicaps often seen in present-day installations.

Replace Obsolete Motors and Control

ADMITTING that power machinery is almost human, that is no reason to keep it in service for man's allotted span of threescore years and ten.

At times this seems to be the idea, irrespective of the improvements and lower operating costs of modern equipment. Even when the improvements may be paid for with savings from the operation of the new machinery, procrastination continues and waste goes on.

There are numerous reasons for obsolescence of power machinery: Old designs do not operate so efficiently as the new. They require more frequent inspection and maintenance. They increase the shutdown hazard and the losses from interruption to service.

At one time it was generally believed that electric motors and control equipment would, with proper maintenance, last indefinitely. This neglected the pertinent fact that it may be too expensive to maintain the equipment. If a record is kept of the maintenance cost of each piece of apparatus, this will be readily found out.

Many old motors are unsuited to their operating conditions, and are not giving the best service in consequence. Replacement of large slow-speed induction motors by synchronous types presents opportunities for improved service, increased efficiency and even better power rates as a result of improved power factor. A new motor may be more economical than an old motor rewound.

Prosperity and Ideas

IT IS fortunate that American industrial leaders, in spite of their individualism, have generally seen the advantage of pooling ideas and experience for the common good. If all had followed the example of the few who build Chinese walls of secrecy around their methods, American prosperity would be an idle dream instead of a glorious fact. Considered as commodities, ideas and experience have a unique property; they can be given away and still remain in the possession of the donor. Thus every exchange of ideas adds to the total real wealth of the world.

The primary clearing houses for industrially valuable ideas fall in four groups—universities, technical books, engineering societies and technical journals. In this work each has its special function.

The service rendered by technical journals, in particular, becomes increasingly important as the tempo of the age increases. In carrying on this essential service the responsibility for collecting ideas from industry, selecting the best and presenting them in the most effective manner, lies on the shoulders of the editors. Industry, likewise, has a very definite responsibility in the matter—removal of the few remaining barriers of medieval secrecy.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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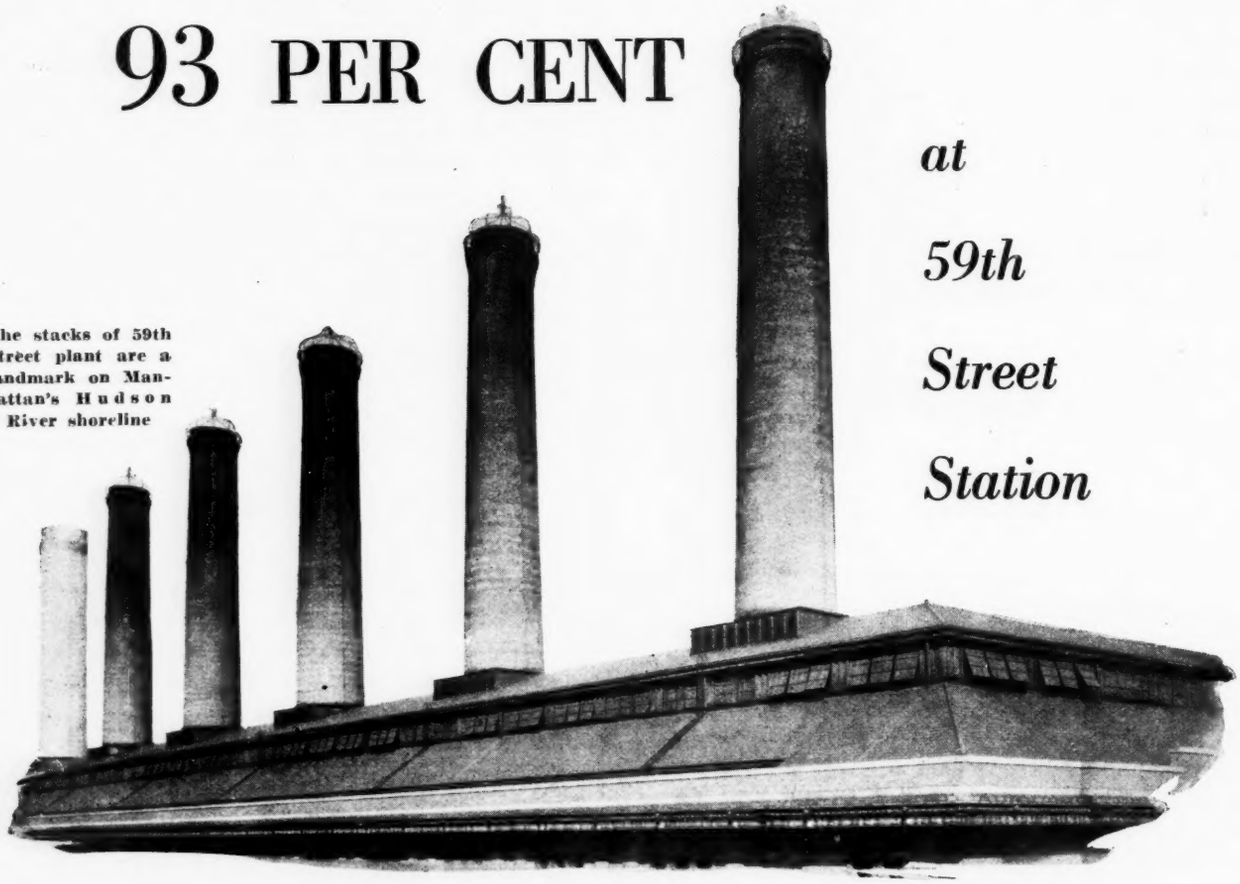
CINDER NUISANCE REDUCED

93 PER CENT

at 59th Street Station



The stacks of 59th Street plant are a landmark on Manhattan's Hudson River shoreline

By **HERBERT B. REYNOLDS**
Mechanical Engineer
Interborough Rapid Transit Company

More subways and fewer cinders! By intensive study the plant which drives much of New York's underground traffic has eliminated 93 per cent of the above-ground cinder nuisance

MOST of the power required for the New York subways operated by the Interborough Rapid Transit Company is generated at the 59th Street power station, situated on 59th Street between 11th and 12th Avenues. The original boiler equipment of this station, which was built in 1904, consisted of sixty 6,000-sq.ft. boilers equipped with hand-fired grates.

The first step taken to increase the capacity of the power station to provide for increased service was to substitute Roney stokers for the hand-fired grates. This was followed by the installation of Roney stokers under the rear of some of the boilers, converting them into double-fired units. During the period from 1914 to 1917 it became necessary to increase greatly the station capacity. This was accomplished by substituting underfeed stokers for most of the Roney stokers and installing forced- and induced-draft fans.

As a part of this revamping and modernizing program it was desired to install some form of cinder-catching equipment. The field was canvassed, but without finding any entirely satisfactory apparatus. In an effort to interest manufacturers in the development of better equipment for this purpose the Interborough company issued specifications for combination induced-draft fans and cinder catchers. The desire to incorporate the cinder-catching feature with the induced-draft fans was due to the belief that space was lacking for separate cinder-catching apparatus. As a result, the two "Cindervane" fans were ordered, each capable of handling 141,000 cu.ft. of flue gas per minute. Although a total of sixteen induced-draft fans was required, it was thought wise to limit the first order to two units of this type because of their experimental nature.

The design of these fans is based on the fact that when cinders enter a fan with the flue gases most of them take a position along the surface of the fan vanes and slide along the vanes until they are discharged at the tips. The fan consists of flat vanes on which are placed a series of channels at an angle of approximately

45 deg. with the shaft. The purpose of these channels is to deflect the cinders to the sides of the fan, where they are discharged into stationary chambers extending entirely around the periphery of the wheel. The cinders pass around in this chamber until they reach an outlet at the bottom of the fan, where they are discharged into a suitable hopper.

The first two fans of this type were installed to serve six 6,000-sq.ft. boilers which had been equipped with underfeed stokers. After testing these two units and studying their operation, it was decided to proceed with the installation of the remaining fourteen units. It was found, however, that the manufacturer could not furnish this equipment at the time because his plant was furnishing munitions for the government. It therefore became necessary to purchase induced-draft fans without any cinder-eliminating features. Although cinder-catching apparatus was available at that time, there was no room for its installation, so the station continued to operate without such apparatus other than the two cinder-catching fans. Soon the discharge of cinders created a serious situation which called for further action.

Removal of Economizers Makes Room for Cinder Catchers

At the time of its erection the station was equipped with cast-iron economizers, each receiving the gases from three boilers. These economizers continued in use until 1925, when their maintenance became too costly to justify keeping them in service. As each economizer occupied a space of 12 ft. wide x 12 ft. high and 32 ft. long, their removal would permit of the installation of almost any type of cindercatching apparatus available.

The field was again canvassed and all types of cinder-catching apparatus carefully studied. At about this time the Green Fuel Economizer Company announced the development of its "Cindertrap," the general principle of which is illustrated in Fig. 1. This equipment consists of a number of vertical flat plates placed in the path of the gases and parallel to the direction of flow. Curved plates are fastened to the flat plates so as to form chambers running from the top to the bottom of the gas passage. The plates are so formed that a small opening is provided throughout the entire length of the chambers and on the side toward the approaching flue gases. The theory is that as the flue gases containing the cinders approach these chambers the cinders, due to their velocity and mass, attempt to continue in a straight line and enter the chamber through the opening already mentioned, while the gases are diverted from their straight-line flow and pass around outside the chamber.

In the commercial equipment four sets of these chambers are placed in the gas flow so that most of the cinders which succeed in getting past the first set will be caught in those that follow. After entering the chambers, the cinders fall by gravity into a hopper beneath the flue. A vent is provided at the down-stream side of the cinder hopper to create a slight flow of gas down through the chamber. This flow is sufficient to aid in carrying the cinders down, but is not of sufficient velocity to carry them up out of the hopper into the flue beyond the trap.

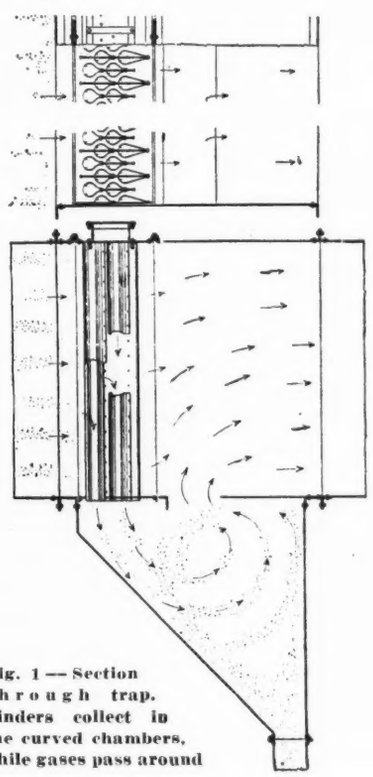


Fig. 1 — Section through trap. Cinders collect in the curved chambers, while gases pass around

To determine the effectiveness of this equipment, ten barrels of cinders were taken from the station and sent to the works of the manufacturer, where they had one of their cinder-catching units set up for test purposes. This unit was approximately 6 ft. high x 5 ft. wide and was connected through a long duct to the discharge of a motor-driven blower. Means was provided for feeding cinders into the blower inlet at a uniform rate. Tests were conducted at various gas velocities during which the weight of cinders fed to the blower was determined, as well as the amount of cinders taken from the hopper at the bottom of the trap. The draft loss through the trap was also measured. The results of these tests are shown in Fig. 2, where the percentages of cinder recovery and draft loss are plotted against the velocities of the air passing through the trap.

It was estimated that in case a trap were designed for service at the 59th Street station the velocity through it would be 2,510 ft. per minute when the boilers from which it would receive flue gases produced a total of 170,000 lb. of steam per hour. Referring to Fig. 2, it will be seen that the percentage of recovery at that velocity is 88, and the draft loss is 0.17 in. of water. Although these tests were conducted with cold air, it was felt that the actual performance under flue gas conditions would be at least as good, if not better, than these tests indicated, due to the lower density of the hot gases.

As a result of these tests one unit was purchased and installed to handle the gases from three boilers. This trap was designed to handle 157,500 cu.ft. of gas per minute at a temperature of 540 deg. F. The unit was 20 ft. high, including the cinder hopper, 15 ft. 8 in. wide and 8 ft. long in the direction of gas flow. It was installed in the far end of the space left vacant by the removal of one economizer. As the economizer space was approximately 32 ft. long and had a cross-section area of 144 sq.ft., it was thought that considerable separation might be accomplished by simply passing the cinder-laden gases through this space, the maximum velocity in the space being approximately 1,000 ft. per minute. In view of this possibility, one additional economizer was removed and the space left to serve as a settling chamber for comparison with the trap.

After the trap had been installed, a record was kept of the amount of cinders removed from the trap and also the amount of cinders removed from the economizer space in which no trap was installed. The boilers on the two units were operated at the same rating during the study. A comparison of these quantities over several weeks indicated that the cinders removed from the economizer space were approximately 45 per cent of those removed from the trap. The cinders were taken from the economizer space through the outlet of the existing hopper, which was located near the far end of the space, where it would be expected that most of the cinders

would accumulate. The volume of cinders removed from the space could have been increased if more effective means had been provided for taking them from the entire length of the space. However, it was believed that in no event would the settling chamber serve as well as the trap, and so steps were taken to install eleven additional units, which, together with the first unit installed, would serve a total of 36 boilers. Although it was decided to install traps, most of the economizer space would still be left and would serve as a settling chamber in advance of the traps, and so increase the over-all efficiency of cinder separation. The remaining boilers had either been equipped with cinder-catching fans or had not been equipped with underfeed stokers, so that no serious discharge of cinders was expected.

However, in the case of all boilers not to be equipped with traps, it was decided to remove the economizers and use the space available as settling chambers. The work of removing the economizers and installing the traps was started in June, 1928, and completed in April, 1929.

To determine the seriousness of the discharge of cinders from the stacks, six test gages were distributed in the immediate neighborhood of the station. These consisted of pieces of 8-in. pipe placed on end and lined with cloth bags to catch the cinders but allow the rain water to drain through. The accumulations of cinders were collected at the end of each month and carefully weighed. From these weights the precipitation expressed in pounds per 100 sq.ft. per month was determined.

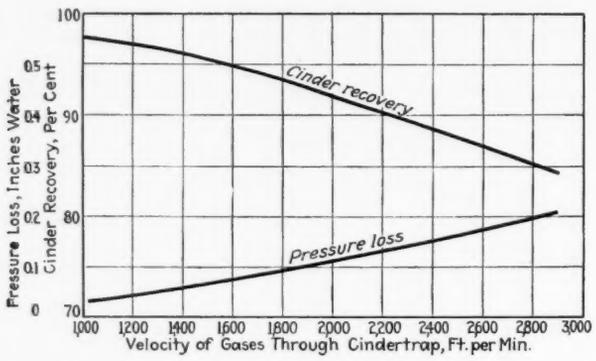

Pressure Loss, Inches Water
Cinder Recovery, Per Cent
Cinder recovery
Pressure loss
Velocity of Gases Through Cindertrap, Ft. per Min.

Fig. 2—Results of factory tests on trap, showing cinder recovery and draft loss with various gas velocities

Fig. 3 shows the results obtained from these gages for the period from April, 1928, to December, 1929. It will be seen that the precipitation during April, 1928, amounted to 18 lb. per 100 sq.ft., while during December, 1929, the precipitation was 1.3 lb. per 100 sq.ft.—a reduction of 93 per cent.

It will be noticed that there is considerable irregular variation of the precipitation of the cinders from month to month. For instance, there seems to be an increase during the summer months, when the load on the boiler room is slightly lower than the winter load. This erratic variation was probably due to the seasonal change of the direction of the wind, together with the fact that it was impossible to distribute the test gages uniformly on all sides of the power station.

No further tests of the efficiency of the traps were made after their installation, due to the difficulty of making such tests. However, the draft loss was determined and was found to be 0.22 in. of water when the boilers that discharged their flue gases through the trap were

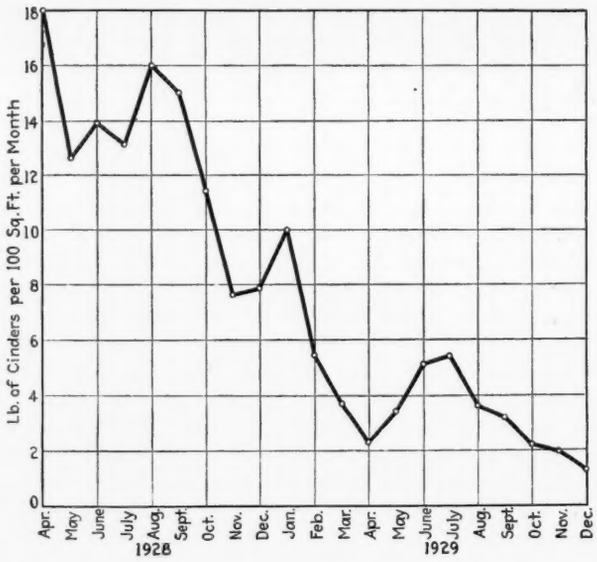


Fig. 3—Precipitation of cinders in vicinity of 59th Street station, showing reduction of 93 per cent from April, 1928, to Dec, 1929

producing a total of 140,000 lb. of steam per hour. About a ton of cinders is removed from each trap during each 24 hours of operation.

It is believed that some additional separation of cinders can be accomplished by installing screw conveyors in the economizer space where no traps have been installed and also in the unused portion of the economizer space where traps have been installed. The screw conveyors would serve to carry the cinders into the hoppers which were originally installed with the economizers to facilitate the removal of cinders. Without the conveyors, it is necessary from time to time to send men into the chambers to remove the cinders by hand, as they become caked and tend to ignite, resulting in smouldering fires.

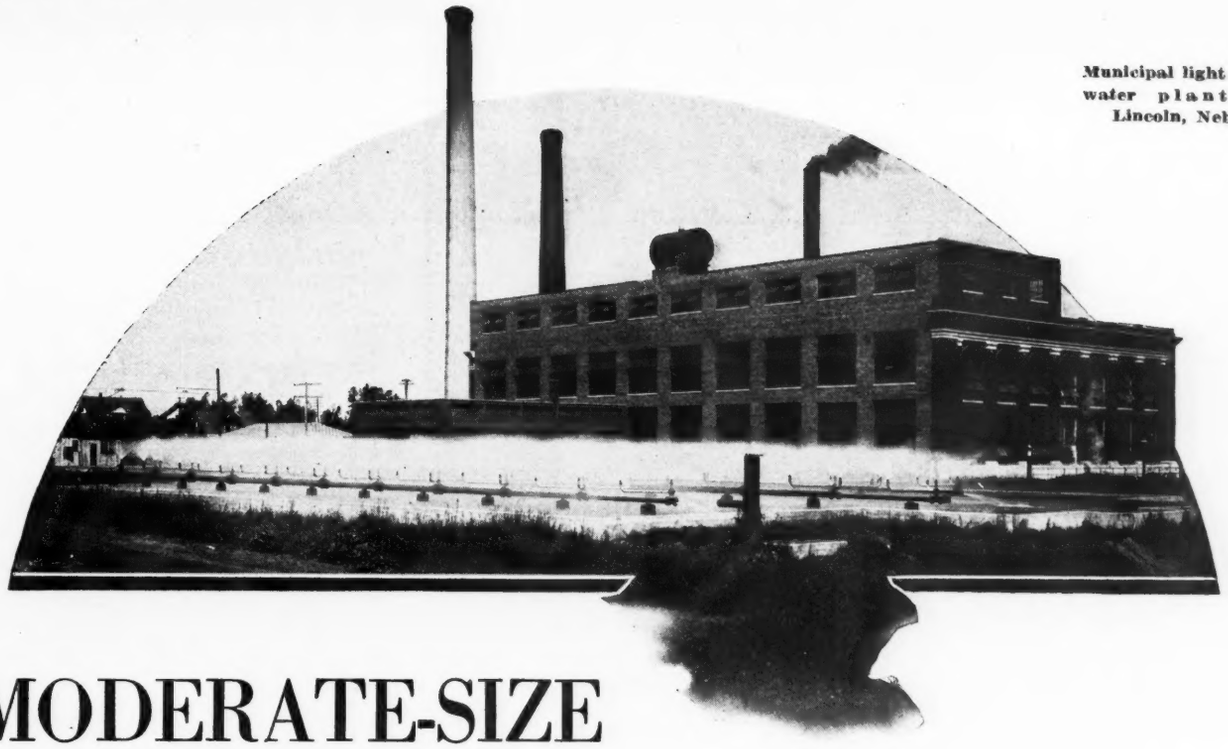
Simple Apparatus for Removing Metal Scale

AFTER years of experimentation, a firm in New England has perfected a method of removal of scale resulting from heat-treating and hardening operations on metals, not only from flat surfaces but from such intricate machine parts as gears, shafts, etc., as well as from cutting tools, such as drills, taps, dies, cutters and reamers. The scale is removed without in any way injuring the surface structure of the steel or metal part.

The process is an electro-chemical one, the descaling action being brought about by the generation of hydrogen on the work, at the same time protecting the work from hydrogen embrittlement or pitting by coating the cleaned work by depositing a metal on it. This coating remains on the work, if it will not interfere with subsequent operations. It can easily be removed electrolytically if found to be undesirable.

This process makes it possible to do away with the hand work formerly necessary, like filing, sand-blasting, scraping and scratch brushing.

The process is said to be so simple that only a small installation is required, embracing a motor-generator for the current and tanks in which the treatment is given. —*Industrial Bulletin* of Arthur D. Little, Inc.



Municipal light and water plant of Lincoln, Neb.

MODERATE-SIZE PLANTS *Can Be ECONOMICAL*

By C. F. LAMBERT
Burns & McDonnell Engineering Company
Kansas City, Mo.

SO MUCH has been written about the super power plant that one is apt to lose sight of the very excellent results obtained from many small modern steam plants that are being operated by cities of from five to fifty thousand population and by industrial companies. Even though these plants are small compared with the immense stations operated by the utility companies, many are giving results comparable with those of the larger plants.

The old steam plant with its fire-tube boilers and its old style non-condensing engines is through. Its economy was so poor that it could not compete in the fast pace set by modern progress. Owners of electric plants of this type find that they have three courses open to them: They must either replace their units with modern steam equipment, substitute oil engines, purchase their current from outside sources, or sell out completely.

Up to a certain size the steam plant cannot compete with the oil engine, because the load does not justify the cost of the auxiliary equipment that is necessary for the most efficient operation of the steam plant. Just where to draw the line between a steam plant and an oil-engine plant depends in each case upon local conditions, such as the price of fuel and the load requirements. As the object of this article is to show the results that can be obtained with moderate-sized steam plants whose sole product is electricity, the discussion will be confined to them.

The reason for the economy of these medium-powered steam plants are many. First, of course, comes the improvement in the equipment itself. The development of pulverized-fuel equipment not only improved the effi-

The purpose of this article is not to present a brief for municipal operation, the consideration of which must include many other factors, but rather to show what many of these medium-size plants are doing. The information is instructive to both utility men and engineers in general—Editor.

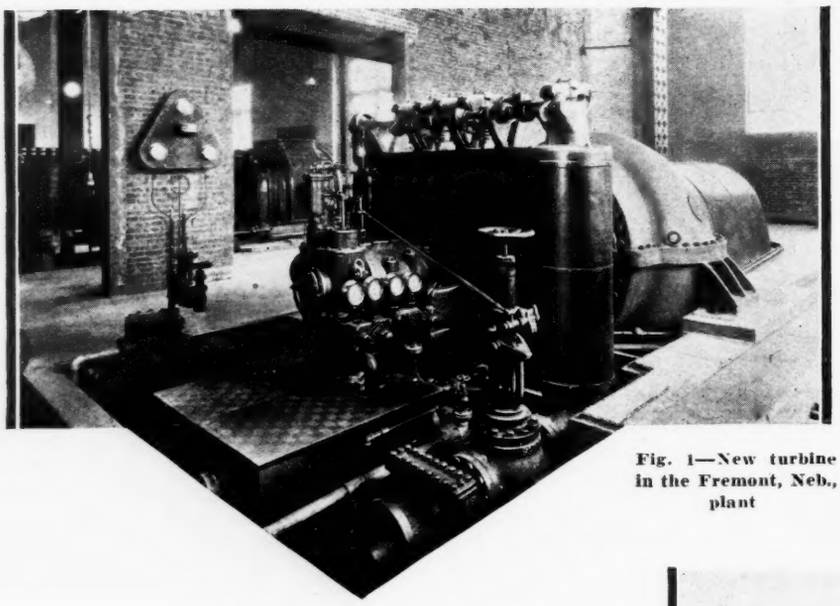


Fig. 1—New turbine in the Fremont, Neb., plant

ciency of plants that adopted this method of firing, but also spurred the stoker manufacturers to greater effort.

The economy of the smaller-size turbines has been greatly increased, and almost all turbines are now constructed for the use of higher steam temperatures. This has encouraged the use of superheat in even the smallest plants. The improvement of load factors has made possible the use of economizers or air preheaters, or both, which has further increased efficiencies. Boiler and turbine room instruments, together with better management, are other factors that have entered into the case.

There are hundreds of plants that come under the type and size as covered by this article, but, of course, space will permit of showing the results obtained by only a few of them.

Fremont, Neb., is one of the outstanding plants of this type. The older equipment consists of two 5,000-sq.ft. boilers with underfeed stokers, and a 1,800-kva. and a 750-kva. turbine. This equipment operates at 200-lb. pressure with 100 deg. of superheat. About two years ago a new complete unit was installed in a new section of the building. This included a 6,000-sq.ft. boiler with underfeed stoker, superheater, air preheater and economizer, and a 3,125-kva. turbine. Space was left for a duplicate boiler, which is now being installed and is shown in Fig. 2. This equipment operates at 300 lb. pressure and 150 deg. superheat.

The plant has a coal rate consistently around 2 lb. per kilowatt-hour with 12,000 B.t.u. coal, and during one month an average of 1.86 lb. of coal was obtained. The output of the plant is about 10,000,000 kw.hr. per year, and the average receipts per kilowatt-hour generated is about 2.5c., with line losses kept to about 7.5 per cent.

Last year Fremont made a net profit of $82,514 after allowing $39,632 for depreciation. The output has increased 700 per cent in ten years. The average use per customer is 2,270 kw.-hr. per year including street lighting and pumping, 2,050 kw.-hr. per year including street lighting, and 1,900 kw.-hr. per year of current sold.

Grand Island, Neb., is another well-equipped and well-operated light plant. The size of equipment and the output is about the same as that of Fremont, except that pulverized-fuel is burned. Grand Island is the larger city, but it has the competition of a private plant and secures only part of the business; nevertheless the output has increased 500 per cent in ten years. The output of the plant is about 8,700,000 kw.hr. per year, and the average receipts generated are 2.3 cents per kilowatt-hour. The average coal rate is under 3 lb. Separate accounts of the water and light plants are not available, but the combined plants made a net profit of $92,471 in 1928 after allowing $52,720 for depreciation. The average use per customer is 2,030 kw.-hr. per year including street lighting and pumping, 1,750 kw.hr. per year without the pumping, and 1,650 kw.-hr. for current sold.

Another pulverized-coal plant of about the same size is Hastings, Neb. About 10,000,000 kw.-hr. is generated annually. A 2,000-kw. turbine was installed in 1927 and a duplicate unit was purchased during 1929. The output has increased about 400 per cent in ten years, and the department makes a net profit of $75,000 per year after allowing 5 per cent for depreciation.

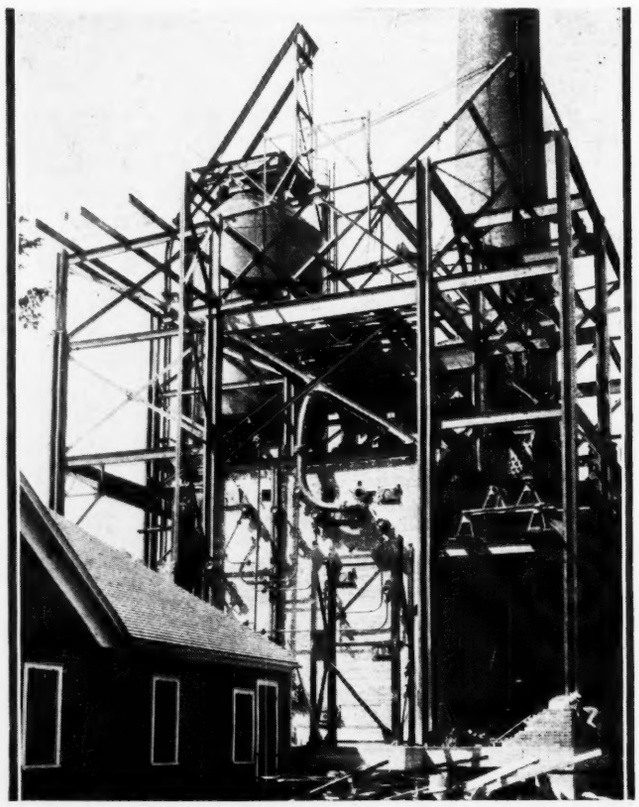


Fig. 2—Fremont is installing a new high-pressure boiler

McPherson, Kan., has a total station capacity of 1,250 kw., consisting of a 500-kw. and a 750-kw. turbine, and a new 2,000-kw. unit will soon be purchased. The total output in 1929 was 2,350,000 kw.-hr., and the average receipts per kilowatt-hour generated were 4.43c. The new boiler and turbine will operate at 375 lb. pressure with 200 deg. superheat. Natural gas and oil are used for fuel. The average use per consumer is 1,085

kw. per year including pumping and street lighting, and 1,000 kw. including street lighting.

The prime movers in the municipal light plant of Virginia, Minn., are two 1,000-kw. and one 1,500-kw. turbine. The output for 1928 was 5,812,300 kw. The net profit for the year 1928 for the combined water and light plant was $64,622 after allowing $62,000 depreciation. The average use per consumer is 1,400 kw.-hr.

STEAM PLANT DATA

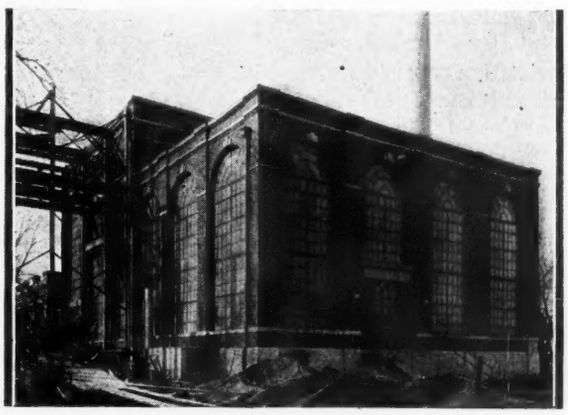
City	Installed Capacity Kva.	Annual Output 1,000 Kw.-Hr.	Lb. Coal per Kw.-Hr.	Receipts per Kw.-Hr. Generated Cents	Load Increase 10 Yr. Per Cent	Annual Profit After Depreciation
Fremont, Neb.....	5,675	10,000	2	2.5	700	$82,500
Grand Is., Neb....	4,250	8,700	2.4	2.3	500	92,471*
Hastings, Neb....	6,250	9,600	2.7	2.7	300	75,000
McPherson, Kan...	1,250	4,350	Gas	4.43	...	45,000
Virginia, Minn....	3,500	5,800	...	2.8	...	64,622
Fairbury, Neb....	3,000	4,500	3.3	3.5	500	51,900
Lincoln, Neb.....	8,950	11,100	2.8	2.2	350	25,000
Springfield, Ill....	15,000	24,500	2.7	2.2	800	212,000
Muscatine, Iowa*.	8,000	11,400	2.9	2.2	500	85,000
Marshall, Mo.....	3,000	3,500	4.5	3.3	700	20,000
Macon, Mo.....	800	1,800	6.0	3.3	100	15,000
Columbia, Mo.....	14,850	9,000	...	3.5	...	.....
Wahoo, Neb.....	1,175	1,500	4.0	4.9	200	20,000
Hannibal, Mo.....	10,000	12,000	...	2.7	...	133,700
Watertown, S. D..	3,000	4,000	4.0	5.2	...	58,000

*Five-year period.

per year including street lighting, and 1,160 kw.-hr. for current sold, with the average receipts 2.8c per kilowatt-hour generated.

Fairbury, Neb., has a 1,000- and a 2,000-kw. turbine and three 5,000 sq.ft. boilers with underfeed stokers, with an output for 1928 of 4,500,000 kw.-hr. The average coal is 3.3 lb. per kilowatt-hour and the average receipts per kilowatt-hour are 3.5c. This plant made a net profit in 1928 of $51,884 after allowing $21,000 for depreciation.

At Lincoln, Neb., the light plant was originally installed to generate current for water pumping. Then the street lighting system was taken over and gradually a considerable commercial business has developed, although the larger part of this system is served by the competing utility. The equipment consists of eight 5,000-sq.ft. boilers and has 8,950 kw. of turbine capacity. The total current generated last year was 11,122,000 kw.-hr., with an average coal consumption per kilowatt-hour of 2.8 lb. Of the current generated 50 per cent is used by the water department, 14 per cent for street lighting and 36 per cent for commercial service. While most of the load is residential and commercial, the average use per consumer is 920 kw.-hr. per year for electric energy sold.



Modern Steam plant of Muscatine, Iowa

Springfield, Ill., is another city that started in the lighting business from the water-works plant. The system has developed quite a commercial business, but, like Lincoln, it is mostly in the residence and commercial classes. The kilowatt-hours generated last year was about 24,500,000. The largest generating unit has a capacity of 7,500 kw., but a new 10,000-kw. unit is to be installed in the near future. A new 10,000-sq.ft. boiler complete with chain-grate stoker, water walls, air preheater and economizer has just been purchased. The light plant last year made a net profit of $211,825 after allowing $105,951 for interest and depreciation. The output has increased 800 per cent in the last ten years, and the average receipts per kilowatt-hour generated are 2.2c. The average use per consumer is 1,210 kw.-hr. per year including street lighting, and 1,040 kw.-hr. for current sold.

Marshall, Miss., has owned its water-works since 1903 and its light plant since 1920. At present the total installed capacity is 3,000 kw. with 2,300 customers using 3,500,000 kw.-hr. yearly, of which 2,500,000 kw.-hr. represents commercial sales and 225,000 kw.-hr. street lighting. The coal used per kilowatt-hour is 4.5 lb., and the average receipts are about 3.3c. per kw.-hr. generated. The output has increased 100 per cent in the past 5 years, and the profit last year after deducting depreciation and making no charges for municipal service was $20,000. Practically all improvements have been paid for out of earnings.

Macon, Mo., has a smaller plant, which has shown good results even though it has not had the advantage of the most modern equipment. Even with hand-fired boilers the plant has kept the coal per kilowatt-hour down to 6 lb. The average receipts per kilowatt-hour generated are about 3.3c., and the load has increased 100 per cent during the past ten years. The annual profit after depreciation for water and light plant is $15,000.

Columbia, Mo., has operated its water and light plant for a number of years, and for some time past all improvements have been paid for out of earnings. Last year a new 5,000-kw.-hr. generator was installed, and bids are now being taken on two new 6,000-sq.ft. boilers and stokers. The coal used per kilowatt-hour is not separated from that used for steam pumps and can therefore not be given accurately. The total output is about 9,000,000 kw.-hr. per year, and the receipts per kilowatt-hour generated are about 3.5 cents.

Wahoo, Nebraska, a little city of 2,200 people, has a modern steam-driven water and light plant. They have just installed a new 750-kw. turbine with surface condenser, which has brought the coal per kilowatt-hour down to about 3.0 lb. The city has just spent $45,000 on the plant out of the earnings and has put in a rate of 8c. for the first 35 kw.-hr and 3.5c. for the balance.

These examples indicate that even a small steam plant, if well equipped and intelligently operated, can produce electrical energy at a low cost. The success of these plants cannot be attributed to high electrical rates, for in all cases cited the rates are comparable with those in towns served by different power sources, and in two instances the municipal steam plants are in direct competition with privately owned plants. As long as coal remains at the present level the medium powered steam plant will be able to show satisfactory operating costs. As the towns grow the installation of large generating units should improve the coal rate and otherwise lead to an even better performance.

CONCRETE SPIRAL CASING and TELESCOPIC PIT RING are

Features of New Low-Head

HYDRAULIC TURBINE DESIGN

By HERBERT J. MUTH
Engineer, Hydraulic Department
Allis-Chalmers Manufacturing Company

A new development in low-head hydraulic turbine design and power house construction that provides flexibility between the turbine unit and the power house structure and reduces the cost of construction is herein described.

SMALL low-head hydraulic turbines have usually been built so that their parts were grouted into or bolted rigidly to the concrete of the power house. This design has certain inherent objectionable features. For practical and economic reasons the sizes of the machine parts are made small in comparison to the surrounding mass of concrete. No proper allowance is made for protecting the turbine from undue stresses likely to be imposed from outside sources. These stresses are due to the deflection of the concrete structure under load and after the flumes have been filled with water; to movement between the power house structure and the turbine itself; and to no provision being made for keeping the correct alignment of the unit, or for readily correcting the alignment if shifting should occur after the parts had been grouted into the concrete.

A design for small hydraulic turbines that ties the unit rigidly into the power house structure, with the objectionable features of the older designs eliminated, has been much sought after by engineers. Recently such a design was developed by the Hydraulic Engineering Department of the Allis-Chalmers Manufacturing Company, and patents have been granted on the new features. In this design simple substantial parts, with comparatively light weight to be carried by power house foundations of the open flume design, are combined with the rigidity, stability, and accessibility of the heavier and more expensive concrete spiral-casing type.

A special feature of the design is a telescopic slip joint, Figs. 3 and 4, which acts as a flexible connection between the turbine and concrete casing to prevent transmitting into the turbine the generator floor loading and other undesirable stresses previously mentioned. This feature permits of lighter construction and eliminates the objectionable supporting columns commonly used with concrete spiral casings. To reduce power house costs

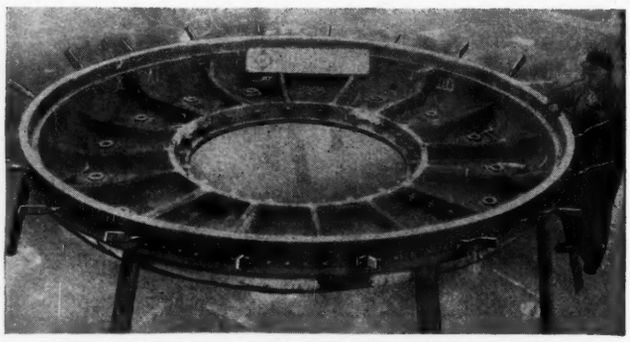


Fig. 1—Cover plate and telescopic pit ring assembled

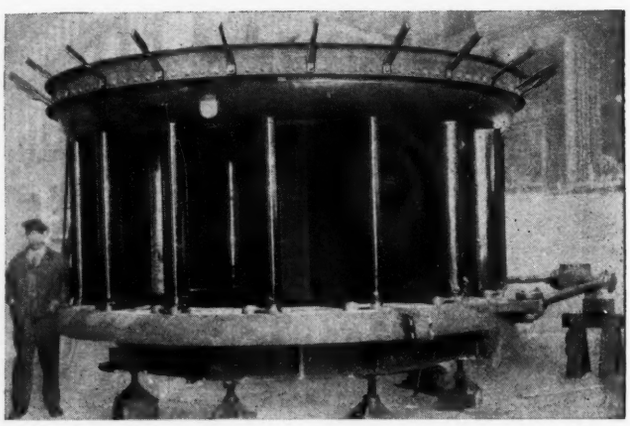


Fig. 2—Turbine casing assembled with telescopic pit ring for grouting into power house floor

by decreasing beam spans, and to improve hydraulic conditions, a nosepiece is formed in the rear of the flume and piers are located in the flume inlet. These, in addition to properly guiding the water to the turbine, serve to break up the floor span and help to transmit the superimposed loads down to the foundations. Piers in the draft-tube chamber serve to form continuous columns with those in the flume for directly transmitting the loads to the power house foundations. Fig. 6 clearly shows this construction.

The new design makes it possible to locate the flume roof at practically head-water elevation, as in Fig. 8. Thus it is no longer necessary to design this roof for high-vacuum loading when syphon settings are used. This was not possible with the old standard open-flume

type construction, Fig. 7, as it was necessary to have sufficient submergence of the guide case and to provide overhead flume clearances for dismantling the turbine.

The submergence of the guide case was obtained in the standard open-flume design by placing the roof of the flume, usually the generator floor for small units, about 6 ft. above the turbine cover plate. The flume was sealed by a curtain wall at the entrance, and the water elevation was raised inside the flume by the syphon action creating a vacuum. This vacuum was first produced by exhausting the air with an ejector located within the flume. The ejectors frequently became clogged and therefore useless. For the old-type syphon setting, the flume roof (the generator floor) had to be designed to carry, in addition to its other loads, the load due to vacuum in the casing. With the new type, Fig. 8, the loading of the flume roof due to vacuum is reduced and in some installations eliminated. The ejectors can also be omitted, since the unit serves as its own ejector for keeping the guide case properly sealed. This feature reduces the power house superstructure costs by decreasing the over-all height of the building.

With the new design it is not necessary to provide large and expensive air-tight hatchways in the power house floor through which to remove the turbine parts. These large hatchways are objectionable, since they break the continuity of the power house floor span and make special reinforcing necessary (see Fig. 7). The new design replaces these large hatchways with small man-

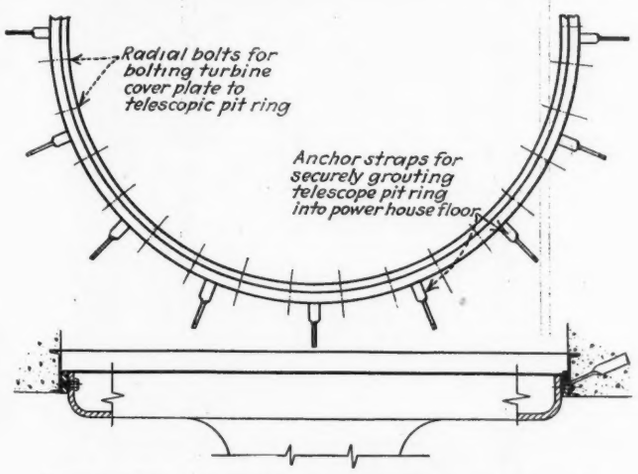

Radial bolts for bolting turbine cover plate to telescopic pit ring
Anchor straps for securely grouting telescope pit ring into power house floor

Fig. 3—Plan and section of telescopic pit ring around the cover plate

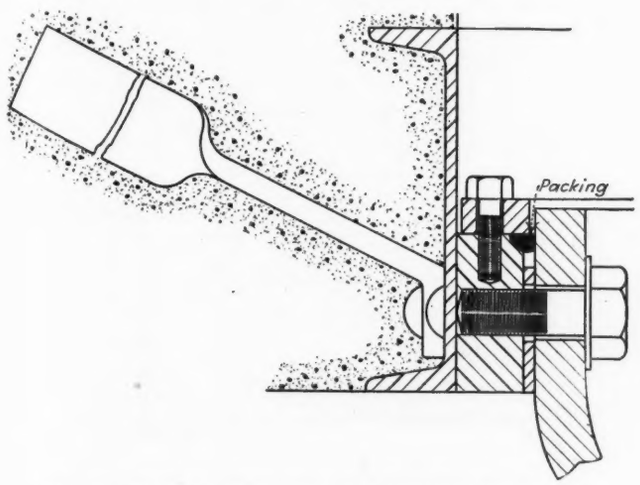


Fig. 4—Enlarged section through telescopic pit ring joint

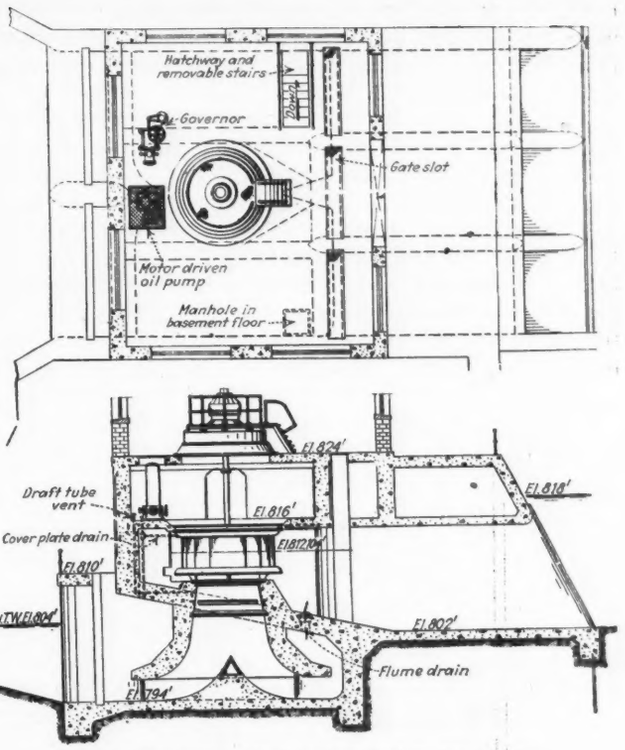
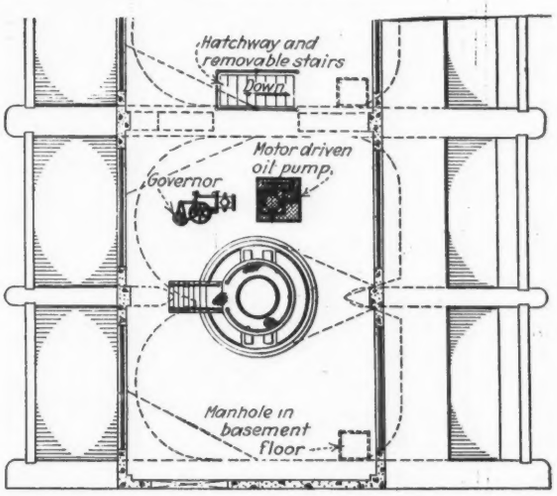


Fig. 5—Concrete spiral casing design for 900-hp. 14-ft.-head unit



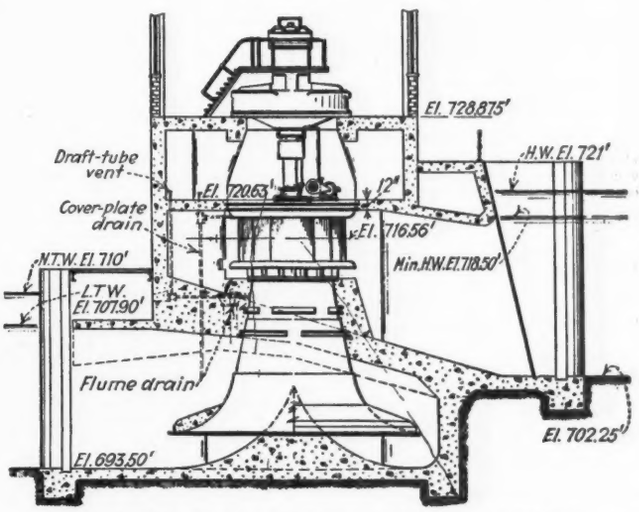
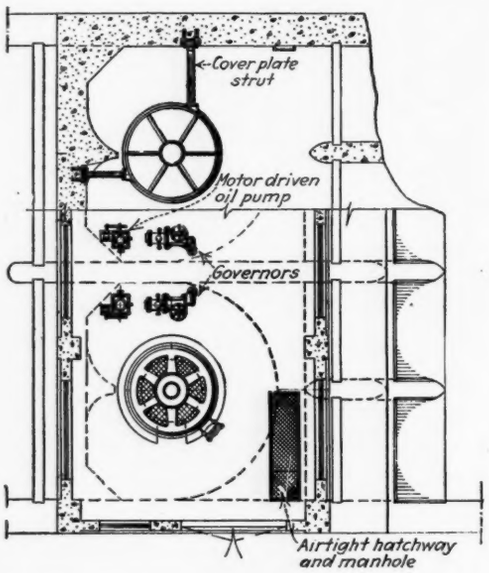


Fig. 6—Two-floor power house design for a 1,170-hp. 12½-ft.-head unit

holes for entrance into the turbine flume, Fig. 8. All the main turbine parts can be erected or dismantled through the telescopic pit ring instead of having to be taken through a large hatchway.

The new closed flume design provides a water-tight compartment over the turbine cover plate so that the main bearing can be conveniently inspected or removed without unwatering the flume. Provision can be made for individual lubrication of the guide-vane bearings from above the turbine cover plate. Rigidity and stability are obtained in the unit by grouting the telescopic pit ring into the power house floor and by bolting the turbine cover plate to this ring, Figs. 3 and 4. In this manner, the turbine becomes an integral part of the



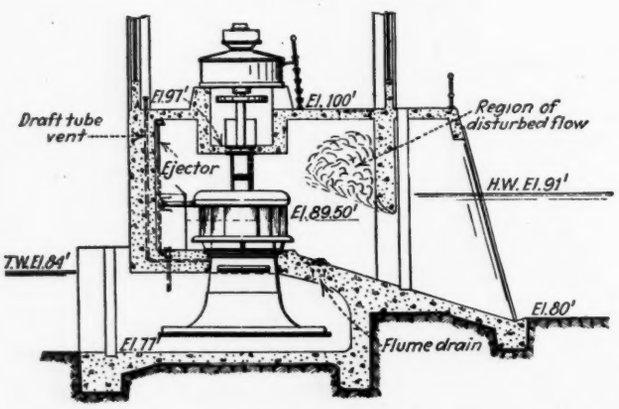


FIG. 7—OLD-TYPE OPEN-FLUME SYPHON-SETTING DESIGN

Here the cover plate has a two-strut bracing; there is a high vacuum under the generator floor, which is elevated 9 ft. above head water; and there is a region of disturbed flow at the inlet to the flume.

power house structure. This feature prevents vibrations caused by the cover-plate struts working loose, as sometimes occurred in the older designs, Fig. 7.

The greater rigidity obtained with the new design allows a larger runner to be used than with open-flume construction. It has been customary to limit open-flume units to capacities of about 2,500 hp. and runner diameters to approximately 9 ft. because of the difficulty in properly bracing the units to secure sufficient rigidity with larger sizes. Hence, units having sizes and capacities greater than those mentioned had to be built with

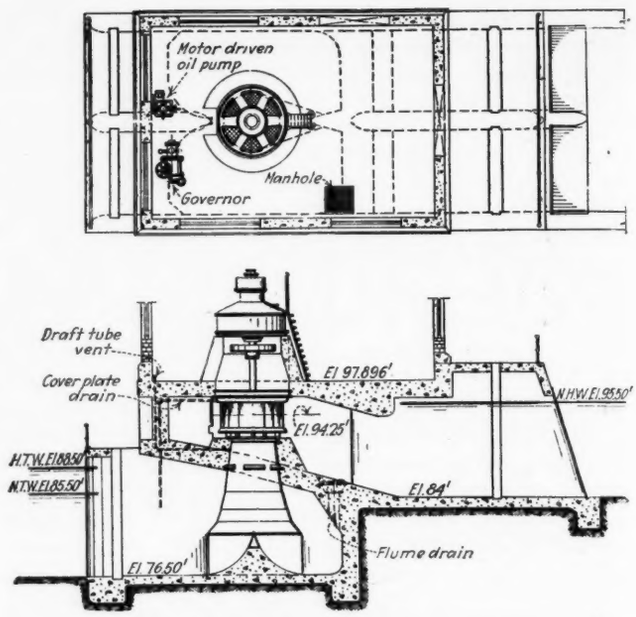
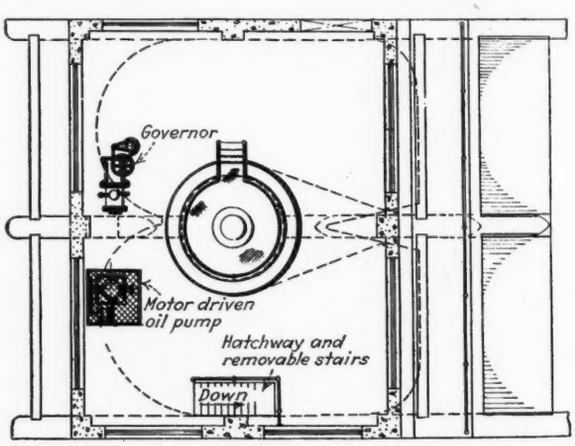


FIG. 8—NEW OPEN-FLUME DESIGN WITH SYPHON SETTING

The cover plate is securely supported in the power house floor, the high-vacuum loading of the generator floor has been eliminated, the generator floor is near head water level and the flow conditions in the intake have been improved over those in Fig. 7.



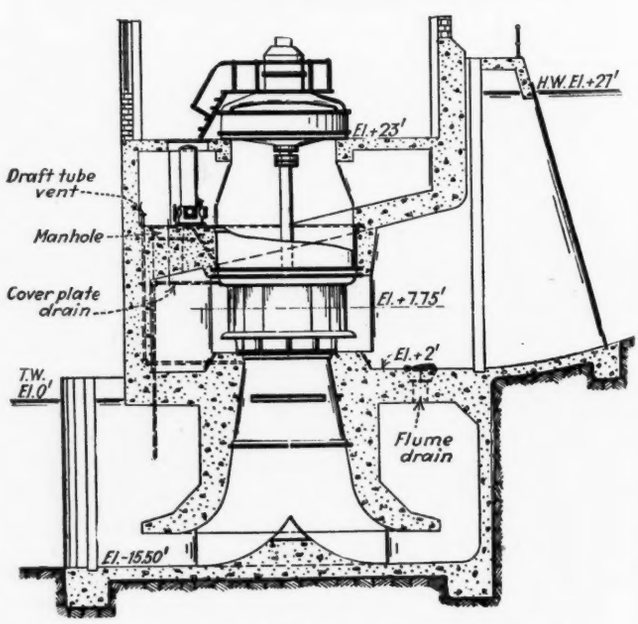


Fig. 9—Concrete spiral casing, telescopic pit ring design for a 3,150-hp. 27-ft.-head 164-r.p.m. unit

concrete spiral cases. In the new design, this feature no longer controls the size of the units.

A slip joint feature, in combination with the telescopic pit ring, also prevents undue stresses in the turbine from the causes previously mentioned. Furthermore, it provides desired flexibility for readily correcting the alignment of the unit if any change occurs after the metal parts have been grouted into place.

In the new arrangement the channel of approach to the turbine in the flume can be designed to prevent disturbances in the passages. Such disturbances are readily carried into the turbine, affecting the operation of the unit. A comparison will show how the region of disturbance inside of the flume, immediately behind the front curtain wall, Fig. 7, is eliminated in Fig. 8.

The telescopic pit ring concrete spiral casing is well adapted to low-head installations requiring syphon settings, Figs. 5 and 8, and to heads up to 40 ft. Units of this design are now in operation under heads of 30 ft. A design for 3,150 hp. and 27 ft. head is shown in Fig. 9.

The weights of units of the concrete spiral casing telescopic pit ring design are slightly greater than those of open-flume construction and are sometimes 50 per cent less than those of units set in standard concrete spiral casings.

The cost of the units of the new type design is only slightly greater than that of the open-flume type, and considerably less than that of concrete spiral cased turbines.

Power house substructure and superstructure costs in the new design are in some instances less than those of open-flume arrangements and are materially less than those of concrete spiral casings. Savings effected in power house and construction costs frequently more than offset the slightly higher costs of units of the new design over the open-flume construction.

Two years of field operation have demonstrated the merits of the new turbine setting. The first unit was placed in operation at the Shawano plant of the Wisconsin Power & Light Company in March, 1928 (Fig. 5). Since then seven other units of this design have been built and placed in service.

▼ ▼ ▼

Time-Delay Relay Used to Measure Volume

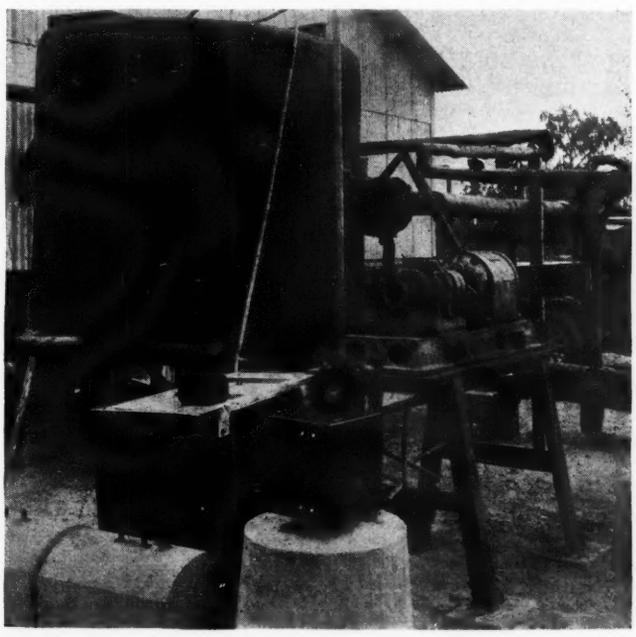
By I. T. Hockaday
General Electric Company
Houston, Texas

THE FLOW OF LIQUIDS has to be measured under a wide variety of conditions, some of which offer special problems. An interesting application of the volume method is found in the Texas Gulf Sulphur Company's development at Newgulf, Texas, where the land is owned by several interests. When leasing the mineral rights, the company found it necessary to pay royalties to land owners in order to make the kind of lease that was agreeable to both parties. Mining sulphur consists of melting it under the ground with hot water and blowing it to the surface in a liquid state by means of air. The question of how to measure the sulphur obtained from each lease came up, and was solved by using a measuring tank into which the sulphur was pumped from a receiving vat.

When the tank into which the sulphur is pumped is filled, the overflow goes back into the vat into which the wells are emptied. The overflow pipe has a gate that swings and operates a control-circuit switch for a motor to operate a valve mechanism. This valve mechanism closes the input valve before the drain valve opens. When the drain valve opens completely, contact is made through a control circuit switch that starts a time-delay relay. After a predetermined time, the final contact is made on the relay and the motor starts in the opposite direction, closing the drain valve before the intake valve is opened. At each end of the travel, a limit switch and a motor-mounted solenoid brake prevent overtravel.

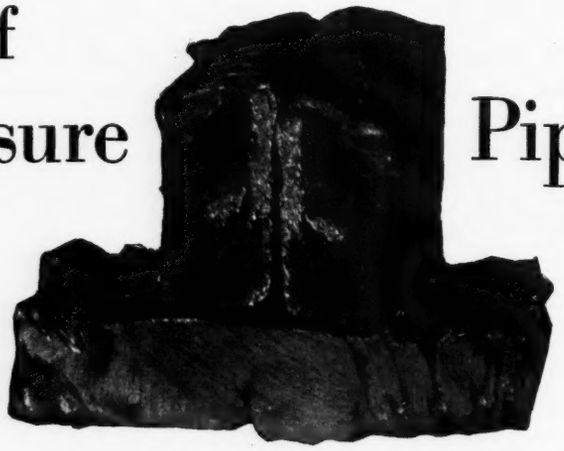
A complete cycle of operation requires about 10 min., and the time-delay relay begins to function when the drain valve has fully opened. The relay insures the drain valve's remaining open to permit the tank to empty under varying viscosity conditions. The number of times the tank had been filled is determined by a counter and a curve-drawing ammeter. This value multiplied by the number of tons of sulphur the tank holds equals the amount of sulphur produced.

The valve is driven by a ½-hp., 220-volt, 3-phase, 60-cycle motor. Fourteen such measuring devices are in use. A general arrangement of the equipment is shown in the picture. This idea, no doubt, has many other applications to measuring volume.



General set-up of the measuring tank and the valve-operating mechanism

ACETYLENE WELDING of Pressure Piping



Samples cut from a circumferential weld in an 18-in. steam line which leaked after nearly five years of service[1]

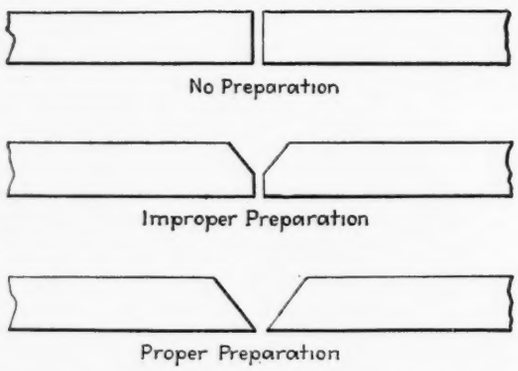


Fig. 1—Improper preparation of welds is a common fault for which there is no excuse

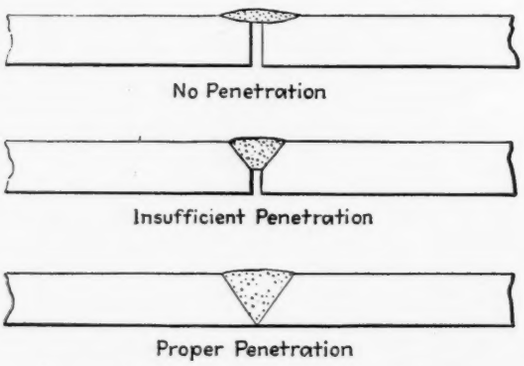


Fig. 2—Without proper preparation complete penetration is difficult and often impossible

Why do welds fail? How can one be sure of a good job of pipe welding? In answering these questions Mr. Michael speaks from the practical viewpoint of one whose primary interest is RESULTS

By H. OSBORNE MICHAEL
Baltimore, Md.

ONLY a few years ago a welder was a welder and that was sufficient. A weld was to be made, a welder was sent for, and he came; usually a very dirty person with his golf cap on backwards, shins incased in puttees, a pair of goggles (usually blue), a sparkler, tanks and a torch, and as many tips as the salesman could talk him into buying.

There was no mistaking a welder; he looked his part. if he was skillful enough or ingenious enough, he made the weld. If it held—good; it demonstrated his skill. If it failed—there was something wrong with the metal to be welded. A welder was not to be questioned; he was master of his mysterious art and would tolerate no interference.

In those days most welders received their training in automobile repair shops, those mysterious places with the reputation of doing little and charging much. From the auto repair shop the embryo welders graduated to the welding shop and after some time there became welders.

Some of these men, with inherent skill, intelligence, and a desire to improve, conscientiously applied themselves and mastered the art. Others, not so painstaking, mastered only as much of the art as was necessary to "get away with it." Some of the former classification went out into industries dealing with high pressures, and further increased their skill. Others of both classifications went with contractors, and, under the rush conditions usually associated with that type of work, either failed to develop further, or lost whatever skill they had acquired.

While the plans and specifications for an addition to a 450-lb., 700-deg. F. steam plant in an Eastern city were

[1]The pressure carried was 200 lb. gage, and the steam temperature averaged 500 deg. F. The upper sample, which shows only a sixteenth of an inch of welded metal, with no preparation or penetration, was cut from the bottom or underside of the pipe. The lower piece was cut from the top. This weld, which was made by a "welder" requisitioned from a well-known firm of steam piping fabricators, on a time-and-expense basis, might fairly be described as an example of criminal indifference.

being drawn up, a number of six- and eight-year old welds made by contractors in an older plant owned by the same company, began to fail by leaking. As each leak developed it was cut out and remade by a welder regularly in the company's employ. Each weld that failed was examined and studied both by a trained metallurgist and by practical men, the company welder also being consulted.

Much was learned about welds. Then, just before the contract was let for the new work, a circumferential weld in a 24-in. header began to leak. This was serious. The study of the welds which had recently failed indicated the cause of the leak and this was not reassuring, as leaks of that kind progress and this one might develop into a rupture at any time, with a reduction of capacity as a minimum result, and a maximum result too frightful to contemplate.

That section of header was segregated, and preparations made to remake the weld. Two employee welders were brought in and the weld was burned out little by little to note the extent of the defects. These were in the form of internal cracks and laps which extended irregularly around the entire under half of the pipe. Above the horizontal diameter the cracks stopped. This indicated that the welder was sufficiently skilled, but was either not conscientious enough or was pushed too hard by his boss to devote sufficient time to making a good weld on the under, or difficult, half of the pipe.

This was the straw that broke the camel's back, and a clause was inserted in the new contract insisting on a practical demonstration by the contractor's welders, the examination of their welds, and the right to reject all submitted welders who could not make excellent welds. Eleven men, all experienced in pipe welding, were submitted and all failed and were rejected. The contractor finally hired a local man who was operating a small welding shop for himself, and paid him enough to neglect his own business for the time.

An additional welder being needed for the maintenance force, it was decided to advertise for a man, with the understanding that a satisfactory test was to determine his fitness. Over 60 men applied during a period of several months. They were of all types and degrees of skill. Only two passed the test with 100 per cent grades; about 60 per cent made a 75 to 80 per cent weld and the remainder were practically ignorant of the essentials of a good weld, while several others were merely bluffing for a job. Several declined to make the test after being told what it consisted of; several gave up after starting, and stated frankly that the weld was too much for their skill; and several more quietly disappeared while the observer absented himself for a moment. One of the satisfactory welders was employed, but the other was working in congenial surroundings at the time and had taken the test merely to rate himself. He was later employed for another department on the record of his test.

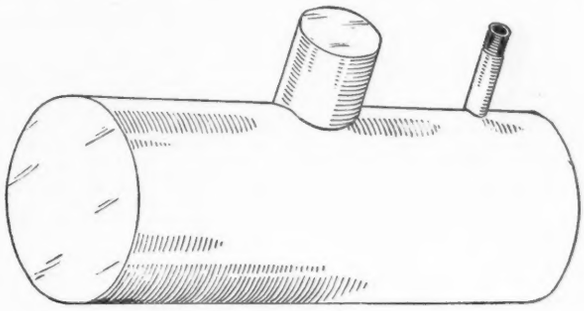


Fig. 4—The general form of a test pipe-weld specimen

These examinations indicated forcibly that bad welds were the rule rather than the exception. If the welders everywhere were no more skilled than those who took the examination (and there is no reason to expect better of them) there must be innumerable faulty welds throughout the many steam stations and other plants using high pressures. A large proportion of this work is new in service and will probably not give trouble for several years, but sooner or later, long before the pipe itself will have deteriorated, these welds will fail.

The question now naturally arises: "How can a weld be judged and how should welders be selected?" The answer follows:

There are several known methods of testing welds without destruction or cutting parts from them: By measuring the electrical conductivity across the weld; by the use of a stethoscope while tapping with a light hammer, and noting the sound; by hammering the vessel while it is under hydrostatic pressure; and by simply applying hydrostatic pressure. Of these four methods, the first, the electrical method, is probably the only one possessing merit, but it would seem to be a laboratory method and not a shop process, and there doubtless are drawbacks to it in actual practice. The stethoscope-and-hammer method depends too much on the acuteness of the hearing, and neither pressure method is of any value.

During the tests previously mentioned, a blank welded in the end of an eight-inch pipe withstood nearly 1,000 lb. hydrostatic pressure, yet was afterward knocked out with a hand hammer. A highly defective weld when new may withstand pressure as well as the pipe itself, yet fail after a period of high temperature and resultant expansion and contraction.

Several additional methods requiring samples from the weld are used. One specifies that a sample be bent

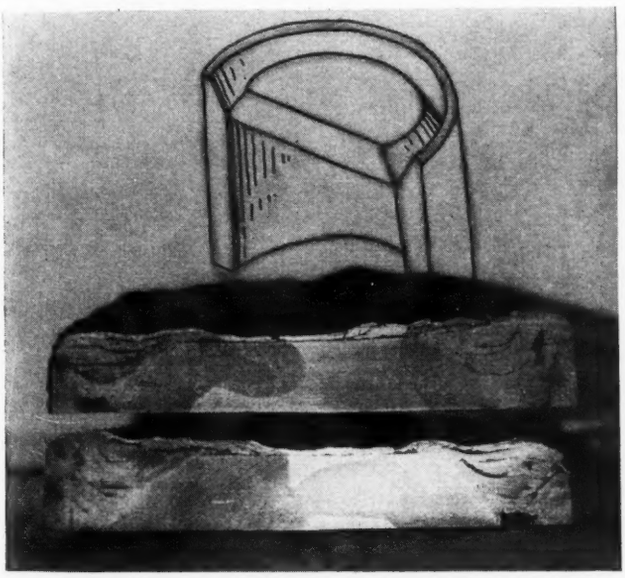


FIG. 3—PHOTOGRAPH SHOWING THE DEFECTIVE WELDING OF A TEST PIECE

Laps and voids are prominently shown. The entire end had evidently been covered over with a layer of welding metal. The sketch in the background shows how a blank and a pipe end are prepared for welding. This end had been sawed off too close to clearly show the side walls of the pipe.

double on itself, revolving on the weld as an axis, and flattened to failure of the weld. The exposed weld material is then to be free of the various defects which will be noted later in detail. Another test is to subject a sample to a tension test, the specimen to withstand a pull of 45,000 lb. per square inch.

The building up of the weld to a thickness one-eighth to one-fourth greater than the thickness of the pipe wall is also practiced, and sleeves and straps are often used to reinforce the welds. The use of reinforcements would seem to be based on an assumption that the welded section cannot be made as strong as the original pipe, which is not true. A defective weld doubtless needs reinforcement, but a good weld does not.

Acetylene welding defects may be grouped into four general classes:

1. Improper or faulty preparation.
2. Insufficient penetration.
3. Failure to properly join the metal, which includes laps and voids (known also as "cold shuts" and by other similar names).
4. Burned or oxidized metal.

Improper or faulty preparation (see Fig. 1) is failure to properly prepare the edges to be joined by welding. It usually indicates an inexperienced or poorly trained welder, but may be the result of indifference, or of rush or hurry-up conditions. By reference to Fig. 1, it can readily be seen that if the edges are butted together for their entire thickness, no welding metal can be inserted between them, and if wedged apart, they can be joined only by using an excessive amount of welding material and consuming an unnecessarily long time. Such welds are usually made by "plastering up" on the outside. This procedure will necessarily be accompanied by insufficient penetration.

Various degrees of penetration are shown in Fig. 2. As previously mentioned, improper penetration often accompanies improper preparation, but may also be the result of inexperience, poor training, indifference, or of rush conditions. Its presence reduces the cross-sectional area of the weld and consequently its strength.

Insufficient penetration is inexcusable. The person responsible for this defect surely sees his omission, and if of any degree of intelligence must know that to insure uniform strength of the finished piece the welded section must be as thick as the sections which were to be welded.

Examples of failure to properly join the metal are shown in Fig. 3. Laps are the product of improperly trained welders, and are caused by the application of layers of metal which are not properly joined either to the original metal or to the welded metal. The metal has evidently been heated enough to make it fluid, but it has not fused to or joined the other metal. This contact may be close, yet not be a weld. The same failure may form actual voids or air or gas pockets. These voids or pockets may also be caused by the presence of scale from oxidation. This class of defects is the most difficult to detect and may be made by welders of long experience who do not realize the seriousness of the defects or who are indifferent. They may also result from rush conditions.

Burned or oxidized metal is usually an indication of an inexperienced welder, although it may result from indifference. A weld nicely finished on the outside may contain burned and brittle metal inside.

These two latter classes of defects are the types which, while giving no trouble for several years, will ultimately fail by the development of small leaks under the constant stresses set up by high temperatures and high pressures.

Following all of this information the reader will ask: "How can proper welds be insured, and welders capable of making proper welds secured?" The answer is: Employ only intelligent, skilled and conscientious welders, pay them a wage commensurate with the importance of their work and length of training, and allow them sufficient time to do good work. This will eliminate contract jobs.

Also, it should be noted here that much of the information furnished by the manufacturers of oxygen and acetylene, and of torches, on the time required for making welds of various sizes is unreliable, in many cases allowing less than one-third the time necessary for properly making a given weld.

It should be simple enough for one experienced in hiring high-grade mechanics to select an intelligent prospect, and his references should aid in determining how conscientious he is. These two qualities are, however,

FIG. 5—THIS PHOTOGRAPH SHOWS CRACKS WHICH DEVELOPED IN A 16-IN. STEAM LINE AFTER NINE YEARS OF SERVICE CARRYING STEAM AT 200-LB. PRESSURE AND 500 DEG. F.

Burned metal is indicated by the rough finish of the weld. Innumerable laps, or cold shuts, were found in the weld when it was cut into for examination. It and four other welds in the same section of line were remade.

unknown to a certain extent regardless of the methods of selection and of securing references.

The degree of skill possessed by the prospect may be determined with considerable accuracy. This requires a demonstration test consisting of taking the welding equipment and several pieces of pipe and the necessary blanks and completing several commonly made welds. Like swimming, or the mastery of any trade, once known is always known. If a welder has ever made perfect welds he can again make them, even after a period of welding on hurried production work.

Fig. 4 shows a test specimen. A piece of 4- to 6-in. pipe has a head welded into each end, the heads to be of thicker material than the pipe walls. A side outlet or lateral is then welded into the large piece of pipe, and a nipple for a pressure connection attached. The thick blanks should be insisted on, as it is more difficult to weld pieces of different thicknesses than pieces of the same thickness. Further, one of the blanks should be welded in while the pipe is suspended vertically at an elevation equal to the height of the welder from the floor on which he is standing.

This part of the test is highly important, as a large

proportion of new welding must be done overhead, and a very great portion of welds, on piping already erected, is done overhead. It is significant that many welder applicants fail in this part of the test, probably through lack of experience in overhead work and methods. Most weld failures develop on the under side of horizontal pipe and welded fittings.

When the test piece is complete, it should be subjected to hydrostatic pressure of at least 1,000 lb. per square inch. Many poor welds will withstand this pressure. Several samples should then be sawed from the test piece. The overhead weld and the side outlet weld are ideal for this. These sections should be ground or filed smooth and finally polished and etched with copper ammonium chloride. If a microscope is available the grain size of the metal can then be examined, but this is not essential, for after etching, such small details as the minute slag inclusions of wrought iron may be seen with the unaided eye, and the line of demarcation between wrought iron and steel welded together can also be seen. Laps, cracks, voids and inclusions stand out prominently. As a physical demonstration the specimen may be placed in a vise and bent partly back on itself to see if any concealed cracks open. Burned metal will show up large shiny crystals at a fracture.

Generally, a weld made at the proper temperature will have a very smooth, almost glassy, outside surface, barring, of course, the irregularities of the welding "puddles"; while a weld which has had too much heat applied has

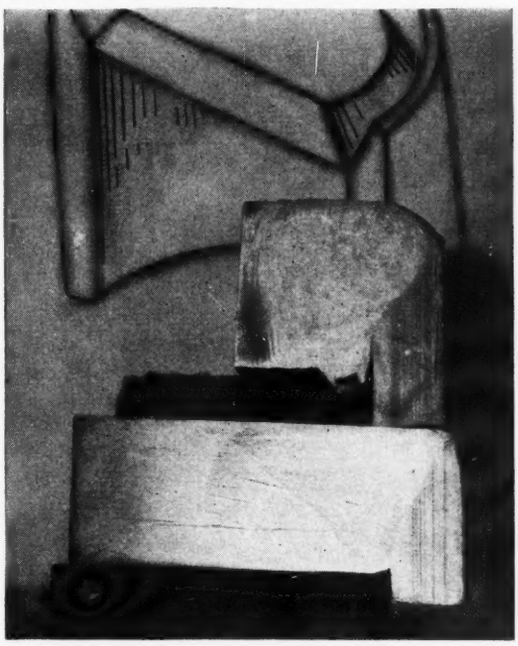


FIG. 6—THIS PHOTOGRAPH SHOWS TWO GOOD WELDS, MADE BY TWO COMPETENT WELDERS, THE LOWER ONE BEING MORE CAREFULLY MADE THAN THE UPPER

The lower weld, which is more carefully finished, might be called a 100 per cent job. The copper ammonium chloride used in etching shows the three different pieces of metal; the blank welded in the end, the welding metal, and the wrought-iron pipe. The thin slag inclusions in the pipe may be clearly seen. (Several lines running horizontally are scratches, made while polishing the test piece.)

a dry, brittle and rough surface. Excessive heat oxidizes the metal—crystallizes it and reduces its tensile strength—and it is quite common for attempted welds to be burned to varying degrees without a bond between the various pieces.

As previously stated, such welds will sometimes withstand considerable hydro-static pressure, yet may be readily knocked apart with several hammer blows. There is a direct similarity between a blacksmith's forge weld and the acetylene weld; it is possible for either to be heated sufficiently to burn the metal without making a weld.

To keep good welders "on their toes" it may be advisable to occasionally examine a weld selected without previous notice. To place responsibility it is desirable to furnish each welder with steel letters bearing his initials, or the significant letters of his name, so that each weld may be marked at the time it is completed, and the maker later identified should any defect develop.

This information should be readily understood, and as the suggested methods of selecting and testing welders, and of examining welds are within the reach of any power plant executive, there should be no further excuse for the acceptance of defective welds.

Cleaning Air Ducts in Large Alternators

By C. B. Stoughton

A POWER COMPANY in the Southeast recently found it necessary to thoroughly clean the air ducts in the stator of a 20,000 kva. waterwheel generator. For some time the machine had shown a tendency to run hot, indicating faulty ventilation. An investigation disclosed the fact that nearly 40 per cent of the air ducts in the stator iron had become completely clogged. It developed that oil vapor, working its way in around the shaft, had deposted a film over the entire surface of the stator. Dust, small insects, etc., adhering to this film had formed a thick, gummy mass which completely plugged a large number of the ducts, thereby decreasing the efficiency of the ventilating system.

The immediate problem of cleaning was made more difficult by the presence of the oil film. It was not only necessary that the dirt be removed, but also that no trace of the oil remain to increase the likelihood of a repetition of this same difficulty.

The method used to clean the generator was as follows: From a local hardware store a quantity of stiff bristle brushes, having wire handles, was obtained. These brushes were of the ordinary type used for cleaning a small gun barrel. The brushes were passed back and forth through the ducts, removing the bulk of the dirt and working loose that which adhered to the inner surface. The outer surface was scraped, using fiber scrapers. Following this a liquid spray was prepared by mixing gasoline and carbon-tetra-chloride in equal parts. The spray was vaporized under pressure of compressed air and blown through the holes. This procedure served excellently to cut the film of oil and also dislodged a considerable quantity of dirt which otherwise would have been very difficult to get at. Finally, the outer surface of the stator and the inner surface of each duct was thoroughly wiped with clean rags, until no trace of the oil remained.

The process was inexpensive and the characteristics of the tools used were such that there was no danger of injuring the insulation of the coils. Less than eighteen hours was required to complete the process.

What's What in

FLEXIBLE COUPLINGS—I

By F. A. ANNETT
Associate Editor of Power

Couplings are an important part of mechanical power-transmission equipment. The developments in flexible types are so extensive that few transmission engineers are familiar with all of them. It was with this thought in mind that this attempt has been made to collect information on all types used in this country. The result of this investigation has been compiled in three articles, of which this is the first (a fourth article will deal with the selection of couplings). In this article couplings that might be classified as pin-type are described.

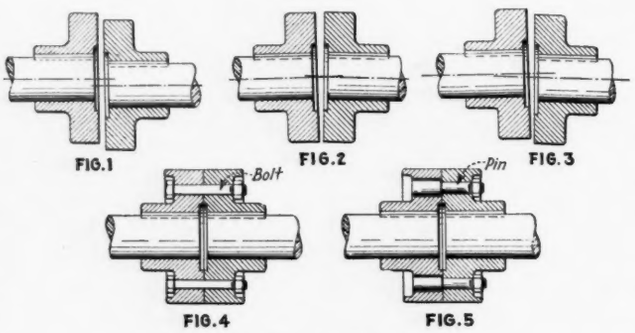
▼

EVEN WHEN a machine and its driving medium are properly lined up there is no assurance that they will remain that way. Distortion of foundations, changes of temperature, wearing of bearings and other causes produce misalignment that should be compensated for. The recognized means of doing this is by a flexible coupling. It should be stated at the outset that there is no real substitute for good shaft alignment. Shafts should be properly aligned and periodically checked for alignment, so that the flexible coupling will be subjected to a minimum of wear and give a maximum of service.

There are three conditions of misalignment that must be compensated for. The first is radial or parallel misalignment, indicated in Fig. 1. In this case the axes of the shaft are parallel to the same straight line, but they do not fall on that line. The amount of misalignment is measured by the radial distance between the axes of the two shafts. A second form of misalignment is known as angular, which exists under conditions where the shafts are not parallel, as in Fig. 2. A combination of one and two constitutes a third and the most common form of misalignment, indicated in Fig. 3.

Any flexible coupling should be able to compensate for a reasonable amount of both parallel and angular out of line of the shafts they connect. Such couplings possess what is known as radial and angular flexibility. Couplings may also have axial and tangential flexibility. A coupling has axial flexibility when it permits a certain amount of end float of the shafts it connects. Most couplings will do this to a greater or lesser degree if properly installed.

Tangential flexibility is that characteristic of a coupling that allows a momentary rotation movement of one half of the coupling relative to the other. This has been termed the ability of the coupling to absorb sudden load shocks. Many couplings possess this quality to a certain degree, but the shock-absorbing ability of couplings is a question on which there is a wide variation of opinion. Tangential flexibility is obtained by the use of elastic transmission elements in the coupling, such as springs, rubber, leather or other materials.



FIGS. 1 TO 5—CROSS-SECTIONS THROUGH COUPLINGS

Fig. 1—Parallel misalignment. Fig. 2—Angular misalignment. Fig. 3—Combined parallel and angular misalignment. Fig. 4—Bolted-type rigid coupling. Fig. 5—Rigid coupling modified to make pin-type flexible construction.

Probably no piece of power-transmitting equipment has been given more attention than couplings. Even though they are usually considered as comparatively simple devices, there have been literally thousands of patents taken out on flexible types. A study of the commercial types will indicate that there are 100 or more in use. Many of them are modifications of the rigid-flange type, Fig. 4. If the coupling bolts, Fig. 4, were replaced by pins fixed in one half and extending into clearance holes in the other half, as in Fig. 5, the coupling would have a certain amount of flexibility. The amount of flexibility would depend upon the clearance around the free ends of the pins. Such couplings have been used. Unless the two halves of the coupling are kept carefully lined up the pins and clearance holes are likely to wear rapidly, the operation will be noisy and unsuited to transmitting heavy loads.

Many flexible couplings in wide use are modified forms of the idea in Fig. 5. These modifications consist of means of increasing the flexibility of the coupling, reducing the wear on the parts and making them operate quietly. One method of doing this is to use flexible bushings on the pins. A coupling of this type is shown in Fig. 6. Special rubber bushings are vulcanized on a metal spool, the bushings being held rigidly on the pins in one half of the coupling and fit into holes in the other half. Instead of putting the rubber bushings on the pins they are placed in the holes, as in Fig. 7.

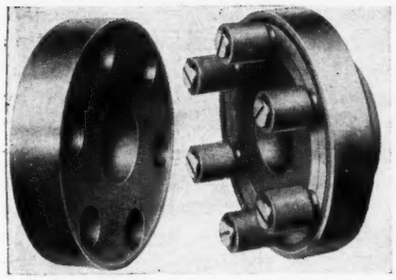


Fig. 6—Pin-type coupling with flexible bushings on the pins

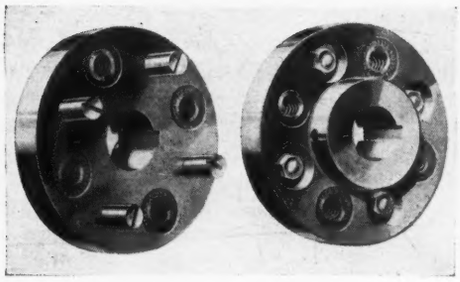


Fig. 7—Pin-type coupling with flexible bushings in the pin holes

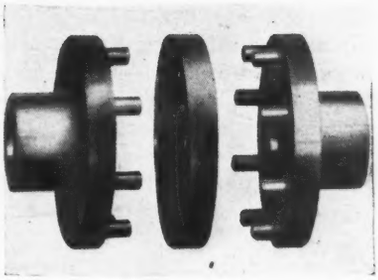


Fig. 8—Pin-type coupling with flexible disk

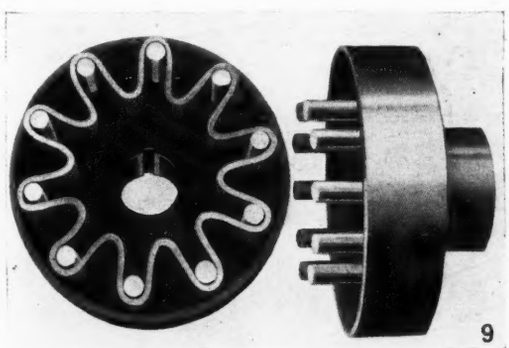
The rubber bushings are cemented into the holes and have a bronze lining cemented inside them. Being made of bronze impregnated with graphite, these linings are self-lubricating.

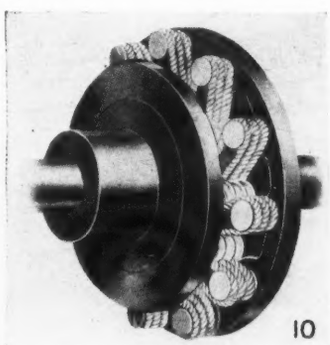
Couplings of the types in Figs. 6 and 7 will compensate for a reasonable amount of misalignment in any direction and they also possess tangential and axial flexibility. The resiliency of the rubber tends to prevent sudden changes of load or shocks being transmitted to the driving medium. Couplings of these types can be built in small and large size and for slow and high speeds. The type in Fig. 7 is built for sizes up to 1,200 hp. at 220 revolutions per minute.

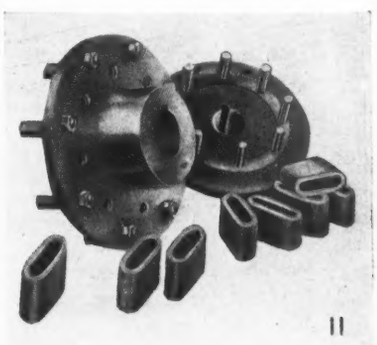
Instead of using non-metallic bushings on the pins, they are made to fit into a rubber, leather or fiber disk, as in Fig. 8. This places a resilient member between the pins and allows flexibility in all directions. What may be considered a modification of the type in Fig. 8 is that in Fig. 9. In the latter a special oil-treated endless leather belt connects the pins in the two halves of the coupling. The pins in one half of the coupling are set on a considerably smaller diameter than in the other half. This arrangement allows the pins in one half of the coupling to move by those in the other, but are restrained by the belt. A design of this type is very flexible and will prevent shocks being transmitted from the load to the driving medium. The types in Figs. 8 and 9 are suited to small and medium capacities up to about 150 hp. at 600 r.p.m. Couplings of the pin-and-belt type are built in large sizes and so designed to allow considerable end adjustment, such as required on Jordan drives. Instead of using a belt on pins, endless ropes are employed on grooved pins, as in Fig. 10. This makes a unit flexible in all directions and is built in sizes up to 1,000 hp. for 100 revolutions per minute.

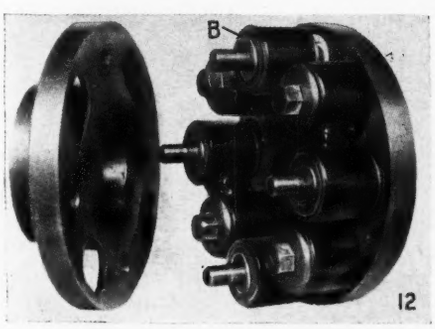
The action of the belt in Fig. 9, and of the rope in Fig. 10, restrains one half of the coupling against the other in much the same way that links would if placed on a pin in each half of the coupling. A coupling of this type is shown in Fig. 11. The links are short endless leather belts that fit over a pin in each half of the coupling. As in Figs. 9 and 10, the pins in one half are set on a smaller diameter than in the other. If the flexible member is removed, one half of the coupling can rotate without interfering with the other.

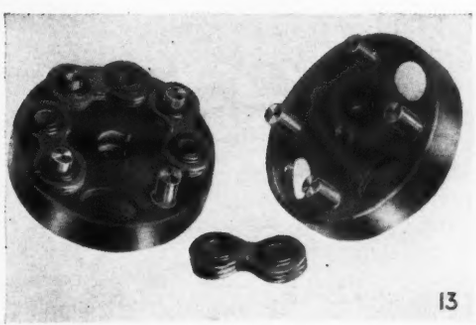
On some types of couplings metallic links with flexible bushings are used. One of these is shown in Fig. 12 and combines the principles of the link-type coupling with those of the bushed-pin type. The links are made of two pieces of round seamless steel tubing electrically

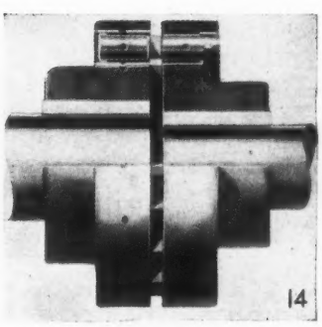












FIGS. 9 TO 14—FLEXIBLE COUPLINGS OF DIFFERENT DESIGNS

Fig. 9—Coupling with endless belt as the flexible member. Fig. 10—Pin-type coupling with endless rope as the flexible element. Fig. 11—Pin-type coupling with leather links. Fig. 12—Metal links bushed with rubber form the flexible element. Fig. 13—Laminated metal links are bushed with fiber rolled into place. Fig. 14—This coupling uses flexible pins.

welded to a center member. On the pin bolt is an elliptical-shaped block *B* over which the special rubber-composition bushing is placed. The pins are held so that the large bearing surface of the blocks gives a uniform thickness of rubber in the direction of the rotational force. This coupling is flexible in all directions and is built in medium and large sizes. Another type of bushed metal-link coupling is that shown in Fig. 13. The links are made of laminated steel, with bushings of special composition fiber crimped and spun into position. The

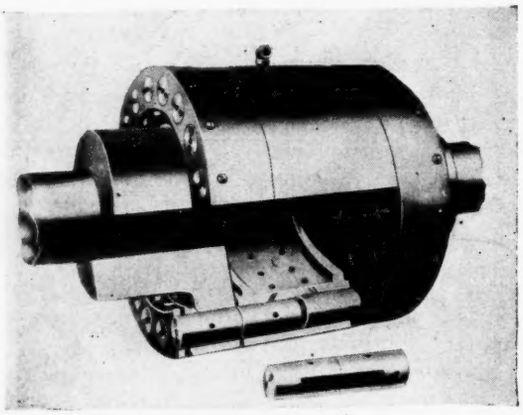


Fig. 15—Double-type flexible-pin type coupling to take care of abnormal misalignment

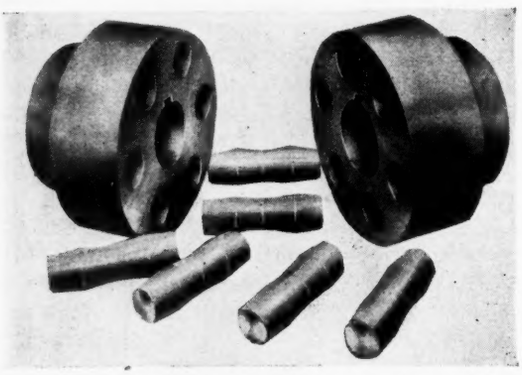


Fig. 16—Double-barrel type pins form the flexible element in this coupling

link-type coupling in Figs. 12 and 13 can be used in reversing service.

A bushed laminated-pin type coupling is shown in Fig. 14. In this type the pins have a flexible member between the two sections that fits in bushed holes in each half of the coupling. The sections of the pins that fit in the holes in each half of the coupling are slotted, and in these slots are laminated steel units. In one half of the coupling the pins are free to move endwise in bronze or in graphited bushings. In the other half they are locked in place by a spring retaining ring, with screws under the ring to insure its going into place and staying there. This coupling is flexible in all directions and provides an effective spring cushion for load shock and vibration. When graphited bushings are provided they are self-lubricating. For severe conditions the bronze-bushed coupling are inclosed and are grease-lubricated. Flexible couplings of this type are made in any size up to the largest capacities.

Where there is likely to be considerable misalignment that can be corrected only at infrequent intervals it is advisable to use double flexible couplings. These may be made with two single couplings with a short length of shaft between them, or they may be specially constructed for the service, as in Fig. 15. This is a double, heavy-duty, flexible-pin type with a cylindrical section between the two halves of the coupling. Each half of the coupling is connected to the cylindrical center by flexible pins of the type used in Fig. 14. The pins are held in the coupling's flanges and are free to float in the center section. This coupling should always be operated within an oil-inclosed case to provide continuous lubrication for the two sets of flexible pins, upon which the floating cylinder may slide or tilt with respect to the shaft flanges.

Fig. 16 shows a coupling that has solid special double-barrel shaped pins to allow flexibility. At about one-quarter of the pins' length from each end, their diameters are equal to approximately that of the holes in the coupling. From these points the pins taper to a smaller

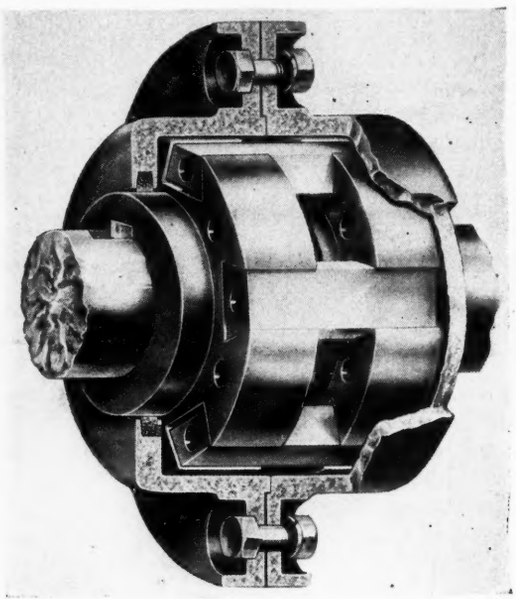


Fig. 17—Coupling hubs have dovetail slots in which are placed floating keys

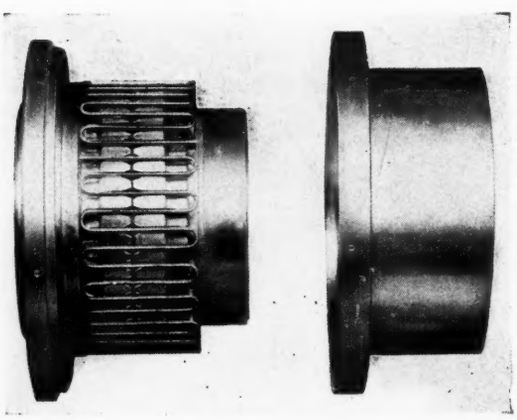


Fig. 18—A grid spring fits into slots in the periphery of the hubs

diameter to allow them free movement in the holes to take care of misalignment in any direction. The shape of the pin is much the same as would be obtained by placing one barrel on top of another. In large-size slow-speed couplings of this type the pins are made of steel, and for high-speed fiber pins are used.

Fig. 17 shows a type of coupling in which the flexible members are floating steel keys in dovetail slots cut in the rims of steel hubs. This coupling operates in an

oil bath, and holes are drilled through the keys and hubs to give a greater oil capacity. The small-size couplings have three floating keys, and the larger sizes have five. The working parts of the coupling are inclosed in a cast-steel casing. Between each floating key and the bottom of the slots in the hubs there is a clearance which accommodates any error of misalignment between the two shafts. The greater this clearance the more misalignment can be taken care of, the amount varying with the size of the coupling.

In Fig. 18 the coupling is also of all-steel construction. It consists of two flanged steel hubs, a specially tempered steel spring forming a cylindrical grid, and a steel shell cover. The peripheries of the hubs are slotted to receive the spring member. The slots widen inwardly toward each other. This widening is in the form of an arc bearing a definite relation to the thickness of the grid spring bars.

The spring grid is the flexible member, and when bent around the arc of the grooves the stresses in the springs are practically constant throughout the elastic range of the coupling. The spring ring fits into the grooves closely only at the outer ends. This gives a long free span between the points of support at light loads. As the load increases, the area of contact between the teeth and spring member increases, thus automatically decreasing the span. The coupling is packed with grease and inclosed in a steel shell that acts as a lubricant retainer and guard. These couplings are made in all sizes and are flexible in all directions.

MANUFACTURERS OF THE TYPES OF COUPLINGS SHOWN IN THE FIGURES

	Manufacturer
Fig. 6—Pins with flexible bushings	De Laval Steam Turbine Co., Trenton, N. J. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Terry Steam Turbine Co., Hartford, Conn. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. T. B. Wood's Sons Co., Chambersburg, Pa. Gears & Forgings, Inc., Cleveland, O.
Fig. 7—Pins in flexible bushed holes	Ajax Flexible Coupling Co., Westfield, N. Y. Philadelphia Gear Works, Philadelphia, Pa. D. O. James Mfg. Co., Chicago, Ill. Foote Bros. Gear & Machine Co., Chicago, Ill.
Fig. 8—Pins in flexible disk	W. A. Jones Foundry & Machine Co., Chicago, Ill. F. A. B. Manufacturing Co., Oakland, Calif. Gears & Forgings, Inc., Cleveland O. D. O. James Mfg. Co., Chicago, Ill.
Fig. 9—Pins and endless belt	Palmer-Bee Company, Detroit, Mich. W. A. Jones Foundry & Machine Co., Chicago, Ill. T. B. Wood's Sons Co., Chambersburg, Pa. Cresson-Morris Co., Philadelphia, Pa. Shartle Bros. Machine Co., Middletown, O.
Fig. 10—Pins and rope	P. H. & F. M. Roots Co., Connersville, Ind. The Webster Manufacturing Co., Chicago, Ill. Weller Manufacturing Co., Chicago, Ill.
Fig. 11—Pins and leather links	Cresson-Morris Co., Philadelphia Pa.
Fig. 12—Fabco	F.A.B. Manufacturing Co., Oakland, Calif.
Fig. 13—Greene	F.A.B. Mfg. Co., Oakland, Calif.
Figs. 14 and 15—Frankie	Smith & Serrell, Newark. N. J.
Fig. 16—Foote	Foote Gear Works, Chicago, Ill.
Fig. 17—Nicholson	W. H. Nicholson & Co., Wilkes-Barre, Pa.
Fig. 18—Falk-Bibby	The Falk Corp., Milwaukee, Wis.

Automatic Throw-Over Equipment for Emergency Service

By C. R. Pitts

Industrial Control Engineering Department
General Electric Company

SEVERAL STATES have laws requiring two separate sources of power for public buildings, such as hospitals, auditoriums, and theaters, and controlled by automatic throw-over switches. It is also becoming general practice to apply automatic throw-over equipment to industrial control where failure of the power source would cause serious trouble. An interesting application has been made in connection with the traffic lights for the Holland Tunnel. The normal power source is supplied from New York and the emergency is from New Jersey.

Automatic throw-over equipment transfers the load from the normal source to the emergency source when the voltage on the former fails, and its transfers the load back to the normal source when its voltage is again restored.

When the equipment is operated on the normal supply, a transfer relay immediately closes. The normal contactor is then picked up through the tips of the transfer relay. Should the normal source fail, the coil of the transfer relay becomes de-energized, opening the coil circuit of the normal contactor and causing it to drop out. At the same time the emergency contactor is picked up through the normally closed tips of the transfer relay. When the normal source again become available, the transfer relay is closed and opens the coil circuit of the emergency contactor and closes the coil circuit of the normal contactor, Fig. 1. This equipment is used where the hum of alternating-current contactors is not objectionable.

Latched-in Contactors

Automatic throw-over equipment for use where noise is objectionable, as in the case of a hospital, is provided with latched-in contactors, Fig. 2. When the panel is operated on normal supply the transfer relay immediately picks up. The normal contactor is then closed, and a latching mechanism drops, mechanically locking in this contactor and at the same time opening the pick-up coil circuit on the normal contactor. The panel is then operating normally and no current is flowing through the operating coil.

Should the normal source fail, the coil of the transfer relay is de-energized, causing the normal contactor, which is held in mechanically, to drop out in the following manner: Power is supplied from the emergency source to the pick-up coil of the normal contactor through the normally closed interlock on the transfer relay, and pulls in the contactor to relieve the spring of the contact tips. The latching mechanism is then free and is raised by a trip coil connected across the emergency source, allowing the normal contactor to open. The emergency contactor immediately picks up and its latching mechanism falls, opening the circuit of the pick-up coil as previously explained and holding the contactor in mechanically. When the voltage is restored on the preferred source, the transfer relay becomes energized, the emergency contactor opens, the normal contactor closes and the panel operates on the normal source.

Automatic throw-over panels may be provided with a time-delay relay attached directly to the transfer relay.

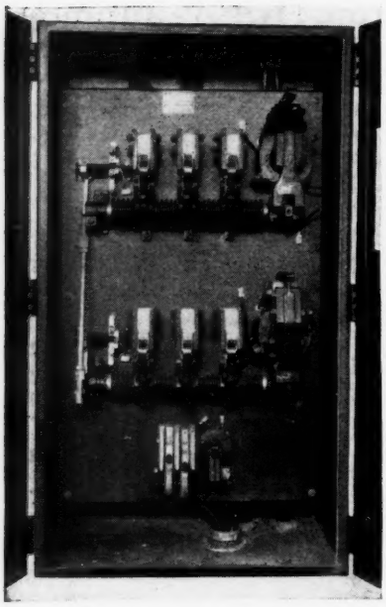


Fig. 1—Standard alternating-current to alternating-current automatic throw-over

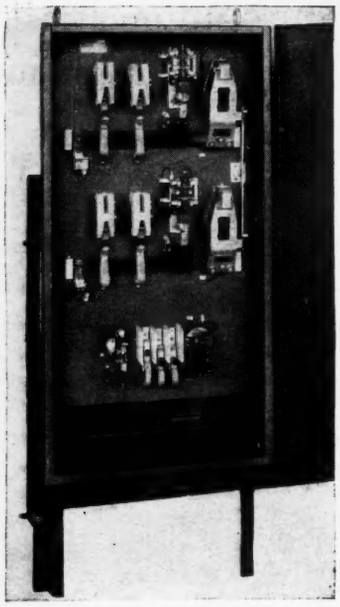


Fig. 2—Standard alternating-current to alternating-current automatic throw-over with latched-in contactors

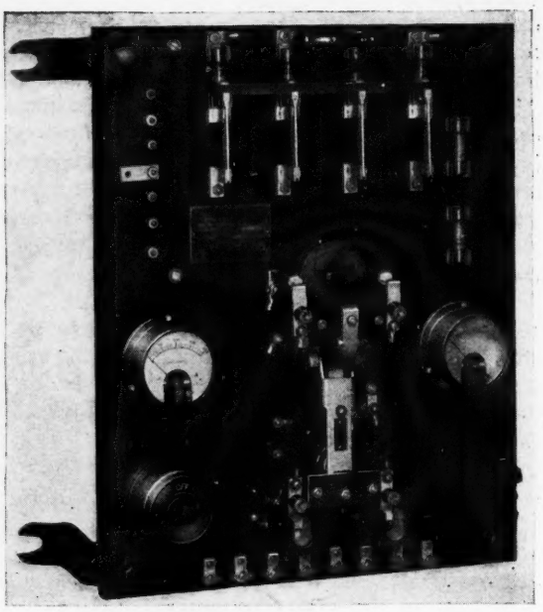


Fig. 3—Standard Alternating-current to direct-current battery-charging and transfer panel

The latter may be set to delay the transfer from one source to the other on momentary complete failure of voltage.

Should it be necessary to make the load transfer at voltages below rated drop-out values, provisions are made on some equipments whereby an undervoltage relay may be attached. Calibrations can be made on the undervoltage relay that will give any desired low-voltage drop-out within reason.

On equipments to throw over from alternating current to direct current it is unnecessary to use a latched-in mechanism on the direct-current contactor.

In cases of emergency in theaters and auditoriums it is often preferred to transfer to the emergency source the exit lights only rather than the entire lighting load. This is done by a direct-current charging and transfer panel, Fig. 3. The normal source is supplied by alternating current and the emergency source is supplied by a bank of storage batteries. Normally, the lights feed off the alternating-current power line through a double-pole, double-throw contactor. At the same time, the storage battery is being charged at a slow rate by a tungar rectifier through a variable resistance. Should the normal alternating-current supply fail, the coil on the double-pole, double-throw contactor will be de-energized. This contactor will drop out and connect the storage battery to the exit lights.

After the emergency source has been operating for some time and the battery is partly discharged, a 4-pole snap switch on the panel can be used to connect the battery directly to the tungar, with the variable resistor out of the circuit. A signal lamp indicates when the battery is being charged directly.

When voltage on the normal source has again been restored, the coil on the double-throw contactor becomes energized, causing an interlock to open the emergency circuit. This is accomplished by a mechanical feature on the normal contactor. A voltmeter is provided across the direct-current emergency source, and an ammeter in the battery-charging circuit.

▼ ▼ ▼

Undersized Conductors May Prove Expensive

By M. E. Wagner

THE DIFFERENCE in cost between reliable and efficient electrical installations and those of uncertain quality is so small that it is difficult to understand why so many of the latter have come into use. First cost is only one of two that must be considered. Furthermore, first cost can be determined beforehand, while the cost of operation is problematical and goes on continuously. One of the largest parts of operating costs may be due to interrupted service. A motor failure that cost a few dollars to repair may be expensive in lost production.

Even though it may be possible to get fairly good service out of poor electrical equipment the cost of doing it may be high, due to excessive maintenance. Undersized conductors poorly installed is a weak spot in many electrical installations. Not infrequently undersize conductors are used in conduits where larger size wires could be used and the increased capacity obtained for the small additional cost of wire alone. Excessive power losses are one of the chief objections to undersize conductors, but there is also the difficulty sometimes experienced with frequent opening of the protective device. The wire size is such that the circuit protective devices cannot be set high enough to take care of the conditions without violating the National Electrical Code. Then it becomes a case of violating the code and overfusing the circuit or staying within the code limitations and taking the consequences of interruptions to service. The only other alternative is to reconstruct the circuit, which could have been avoided at small expense by properly designing the original layout.

Composition of the Air Charge in a Crankcase-Scavenging Diesel

By ALFRED PETERS

THERE has always been a question as to the composition of the air charge in a crankcase-scavenging Diesel, and few attempts have been made to analyze this air. Some experiments have analyzed the exhaust, but the results do not give a fair picture of the composition of the cylinder charge during composition and combustion, due to the detention effect of the scavenging air.

Some time ago a careful study was made of this subject in the shops of a large engine builder. The engine on which these tests were conducted was of the low-compression, single-cylinder, vertical, two-stroke-cycle type, its compression pressure being about 250 lb. per square inch. It had a bore of 9.5 in. and a stroke of 12 in., and running at 360 r.p.m. its normal rating was 25 hp. Scavenging of the exhaust gases was performed by the inclosed crankcase.

Small valves were fitted to the cylinder and combustion chamber, and suitably connected to the sample flasks to obtain samples of the combustion air and exhaust gases. These valves were mechanically operated from the crankshaft and timed to suit the various conditions. The combustion chamber arrangement is shown in the illustration. The gases were analyzed in an Orsat apparatus. The tabulation gives the average results under various conditions. The load carried during the test was 27 horsepower.

RESULTS OF TESTS

Timing of Sample Valve	Analysis of Gases, Per Cent CO_2	O	CO
1—Valve in cylinder—Opened just after piston covers ports on compression stroke	1.0	19.0	0
2—Valve in cylinder—Opened 30 deg. from top dead center on compression stroke	1.0	18.8	0
3—Valve in combustion chamber—Opened 88 deg. from top dead center on compression stroke	1.9	17.8	0
4—Valve in combustion chamber—Opened 10 deg. after top dead center on expansion stroke	3.7	15.6	0.1
5—Sample collected from exhaust manifold	4.0	16.6	0

It will be noted that the oxygen contents in samples 4 and 5 were surprisingly high, but are, no doubt, the average encountered in low-compression two-cycle crankcase-scavenging engines. The fact that the percentage of oxygen in sample 5 is higher than in sample 4 is due possibly to a small amount of scavenging air having escaped into the exhaust pipe.

The fuel consumption in the above tests was between 0.55 and 0.60 lb. per horsepower-hour, which is very good for an engine of this type.

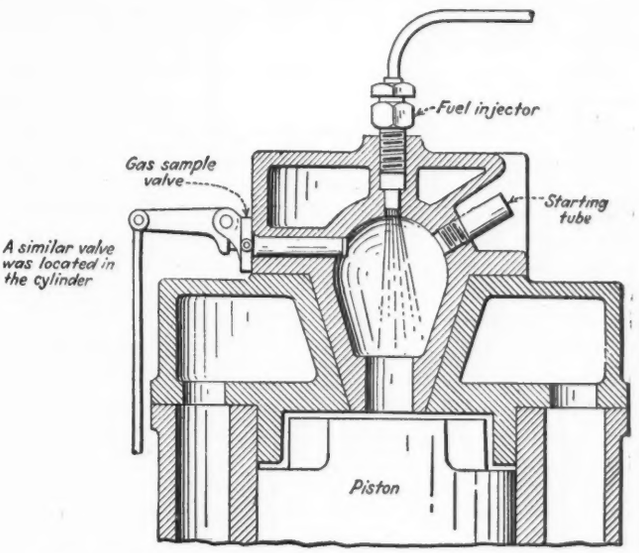
These tests were conducted some time ago, and since then the crankcase-compression engine has been more or less superseded by the high-compression, cold-start engine with outside scavenging pump.

It would be of interest to know just what progress has been made on the better utilization of the oxygen in the scavenging air. While no actual tests are available, the following illustration will throw some light on the subject.

A well-known manufacturer recently brought out a 6-cylinder, $10\frac{1}{2}$ by $12\frac{1}{2}$ engine with outside scavenging pump, rated at 300 b.-hp., with a fuel consumption of 0.46 per horsepower-hour. The scavenging pump dimensions are not known to the writer, but undoubtedly the pump has a displacement equal to over 100 per cent of that of the combined power cylinder. On this assumption, the displacement per power cylinder per stroke is 1,082 cu.in., or 389,650 cu.in. per minute and 13,530 cu.ft. per hour.

Since the fuel consumption is stated to be 0.46 lb. per hour, the total amount of fuel used per hour per cylinder is $0.46 \times 50 = 23$ pounds.

For complete combustion, there is required, theoretically, approximately 177 cu.ft. of air for each pound of



Arrangement of sampling valve in the combustion chamber

fuel oil. Therefore, for 23 lb., $23 \times 177 = 4{,}070$ cu.ft. is necessary. It will be seen that only $4{,}070 \div 13{,}530 = 30.1$ per cent of the available air is utilized in the very latest two-stroke-cycle solid-injection Diesel engine with outside scavenging pump, or, expressed in the same terms as in the above tests, only about 6.3 per cent of the oxygen is actually used for combustion, and approximately $21 - 6.3 = 14.7$ per cent remains unused in the exhaust gases.

In these calculations it is assumed that the scavenging air contained the normal 21 per cent of oxygen of the atmosphere. It is possible that some of the burnt gases are not swept out of the cylinders, and dilute the scavenging air. However, in an engine with outside scavenging pump, the scavenging air should be much more nearly 100 per cent pure than in the crankcase-scavenging type. But, even if we assume that there were only 19 per cent of oxygen present, as was the case in the crankcase-scavenging tests, we find that still $19 - 6.3 = 12.7$ per cent oxygen escapes unused with the exhaust gases.

. . . RIGHT OUT OF THE PLANT . . .

Improved Method of Installing Discharge-Gas Heater

VARIOUS pieces of apparatus have at different times been designed for a specific use in power or refrigerating plants, and after having been installed and put in operation have shown certain benefits other than those which they were primarily intended to accomplish.

A good example of this is found in the discharge-gas water heater installed in ice and refrigerating plants primarily to obtain a supply of hot water by abstracting the superheat of the discharge gas from the ammonia compressors. After this piece of apparatus had been in common use for some time certain other benefits became apparent, making it of greater value than had been originally anticipated.

While acting as a water heater it at the same time removed practically all of the superheat of the discharge gas, thus adding to the capacity of the condenser, which proved in many plants a very desirable feature, and particularly so where there was a shortage of condenser capacity. Furthermore, by providing a means of lowering the velocity of the gas and at the same time cooling it, it proved itself to be the most effective oil trap so far developed, and in later installations this apparatus has been installed primarily for this purpose.

To obtain the best results from any apparatus it is necessary that it be installed so that it is accessible to the operator at all times and that the installation embody those features that permit of easy operation and at certain predetermined rates.

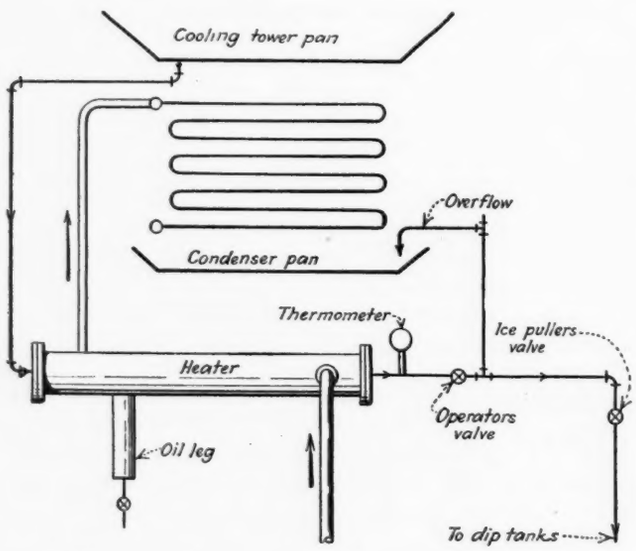
In the case of the apparatus in question it is necessary that a certain rate of water flow be maintained and that the means of adjusting this flow be convenient to the operator, and solely under his control.

In some instances, through lack of foresight, installations have been made with some undesirable features, such as where the continuous operation is independent of the operator (as would be the case where the water flow is under the control of an ice puller). The ice puller adjusts this flow to meet his demands for hot water and without any knowledge of the correct rate of flow to obtain the most desirable results.

An installation where due regard has been given to accessibility and where the operator has complete control of the necessary adjustments to obtain the correct rate of water flow for each operating condition is shown in the accompanying illustration.

A thermometer and a valve in the water outlet permit the operator to adjust the flow independent of the ice puller and thus keep the heater working at a uniform rate regardless of the demand for hot water. It is apparent that the maximum flow is determined by the operator, and should the hot water demand fall below this the surplus will overflow into the condenser pan.

Chicago, Ill. JULIUS BRODSKY.



Heater connections arranged to give operator independent control of waterflow

Correcting Fuel Oil Volume

IN *Power,* March, 11, Herbert S. Ender presented a chart correcting Diesel or fuel oil volumes for temperature. Unfortunately, he did not give the gravity of the oils from which he obtained his figures, nor the field from which they came, both important factors in exact determinations.

The Bureau of Chemistry gives a factor of 0.00064 per degree Centigrade as the average of most vegetable and mineral oils. With the Fahrenheit scale, used by the petroleum trade, this factor becomes 0.000355.

I suppose Mr. Ender is familiar with the correction book for the Baumé scale. This was figured for paraffin-base oils, while most of the fuel oils on the market are either from mixed- or naphthene-base oils which do not conform exactly to the standard scale.

For rough calculations it is customary to add or subtract one degree Baumé for each ten degrees fall or rise in temperature from the standard (60 deg. F.). With commercial gasolines, this gives close results, since the factor is about 0.0004 per degree F.

With heavy oils or with very light gasolines, this is

not accurate. Then a correction table is used or the oil is tested by hydrometer after heating or cooling to 60 deg. F.

The residual materials from the various cracking processes are now extensively used for fuel purposes. On running tests with residuals from the Mid-Continent field, I have found that the heaviest of these contain tarry substances, which, when removed, raise the Baumé gravity of the clarified oil 3 to 4 deg. and reduce its viscosity very materially. Thus a 10 to 12 deg. Baumé oil becomes 14 to 16 deg. Baumé, which is to be preferred.

The paraffin-base oils have a formula of Cn $H_2n + 2$. These oils are confined to the Appalachian and Wyoming fields, though some Oklahoma oils are similar. The naphthene- (asphalt) base oils have a more complex composition, approximating that of the benzol ring, $C_6 H_6 + nCH_2$. The residue from cracking is similar to tar or asphalt. Various other combinations have been identified, but the two mentioned are in the majority.

To my knowledge no table has been worked out for a pure naphthene-base oil, so I hope Mr. Ender continues his good work, particularly if he is using Mexican or Gulf Coast crude and its derivatives.

The Mexican field has furnished some freak oils. One was heavier than water and yielded 25 per cent of straight-run gasoline. Another, with a viscosity of 2,700 sec. (practically that of a grease), yielded straight-run gasoline and kerosene and left a fuel oil with a viscosity of 300 sec., reversing the usual procedure.

Cleveland, Ohio. L. R. BAKER.

Power From Ice Water

DR. BARJOT'S idea, as outlined in *Power* for March 11, for obtaining power from ice water in the Arctic wastes is so fascinating that one hesitates to examine it with a suspicious eye. However, there are a few items which cannot be ignored. A point has undoubtedly been made with respect to the turbine required, and although nothing authoritative can be said about the size of machine without knowing the thermodynamic qualities of the hydrocarbon to be used, it is safe to say that a turbine using such a fluid will be larger per kilowatt output than will one using steam. A steam turbine-generator unit of moderate size will cost at least $25 per installed kilowatt, which alone exceeds Dr. Barjot's estimate for the entire plant.

Another point is the cost of fuel and ash handling. In this case the "fuel" is water at approximately 32 deg. F., and the "ash" is ice at about the same temperature. The freezing of the water makes available the latent heat of fusion, 144 B.t.u. per pound, which vaporizes the hydrocarbon. One kilowatt-hour equals 3,415 B.t.u. Consequently, at 100 per cent efficiency 23.7 lb. of water must be frozen for each kilowatt-hour output.

Inasmuch as the best steam plants have about 25 per cent over-all efficiency, it is oversanguine to expect the hydrocarbon plant to do better, and we arrive at a figure of 95 lb. of water per hour to be pumped from below the ice pack per kilowatt-hour. Unfortunately, an equal weight of moist ice must be disposed of. For a 1,000-kw. plant this will mean conveying 42.5 tons of ice crystals per hour at a temperature well below zero. Possibly this can be taken care of by another brine circulating system adding to the auxiliary power consumption. It is mentioned in the article that the weight of water to be frozen in the boiler is roughly the same as that of the cryohydrate which must be frozen in the troughs on the ice. It seems peculiar that the water at 32 deg. is frozen almost instantly in a relatively small boiler through contact with the hydrocarbon at —6 deg. F., while the cryohydrate exposed to a lower atmospheric temperature must have abundant trough area and apparently an appreciable time element for freezing.

Oak Park, Ill. E. S. SMAIL.

Meter Correction for Wet Steam

IN *Power* of March 25 there was an answer to a question involving the effect of moisture in steam upon flow-meter readings, and the answer was incorrect, I believe.

A flow meter does not really measure volume, but rather an interchange of pressure and velocity heads; therefore, to correct a flow-meter reading for a certain percentage of moisture when it is calibrated to read correctly with dry steam at a certain pressure passing through it, it is necessary to multiply the reading by $\sqrt{\frac{D_1}{D}}$ instead of just $\frac{D_1}{D}$. This is the general flow effect correction, and applies not only to moisture but to pressure and superheat conditions as well.

For small percentages of moisture, if D represents the density of dry steam at the pressure, D_1 will equal $\frac{D}{X}$, in which X represents the quality of the steam. The correction factor, therefore, is equal to the square root of $\frac{X}{1}$. A. A. MARKSON.

New York City.

[The original answer was incorrect. The correction factor should have been $\sqrt{\frac{D_1}{D}} - 1$.—L.H.M.]

How the Welding Torch Was Utilized in a Compressor Installation

IN THE installation of small two-stage compressors a considerable reduction in cost may be effected by welding as much as possible. Practice has demonstrated that even in high-pressure discharge lines, where a pressure of 1,000 lb. is often attained welding is permissible.

Starting at the steam end, the separator can be made in the field from a piece of 6- or 8-in. pipe 24 in. long, the details of construction and general dimensions being shown in Fig. 1. The outlet pipe is so placed that the flat plate on the upper end will be about 3 in. from the inlet. The separator is welded into the steam line at a point just above the throttle valve. The rest of the steam line to the boiler is also welded at the joints.

The unsightly custom of leaving steam drains open to the floor is also done away with. These drains, $\frac{1}{2}$ and $\frac{3}{8}$ in., are run into a $\frac{3}{4}$-in. header placed about 8 in. below

the cylinder. This, in turn, is welded into a ¾-in. drop into a 2-in. main drain. There are no fittings other than nipples and unions (Fig. 2), all connections being welded.

At the gages there is often an accumulation of water and oil in sufficient quantities to impair their accuracy; also, in the case of high-pressure gages the shock due to water in the air may be sufficient to cause damage. This is taken care of by means of a drip bottle or absorber (Fig. 3) made from a piece of 4-in. pipe 18 in. long with "orange peel" type heads. Any pulsation in the pressure is absorbed in the bottle, and any oil or water can be periodically drawn off.

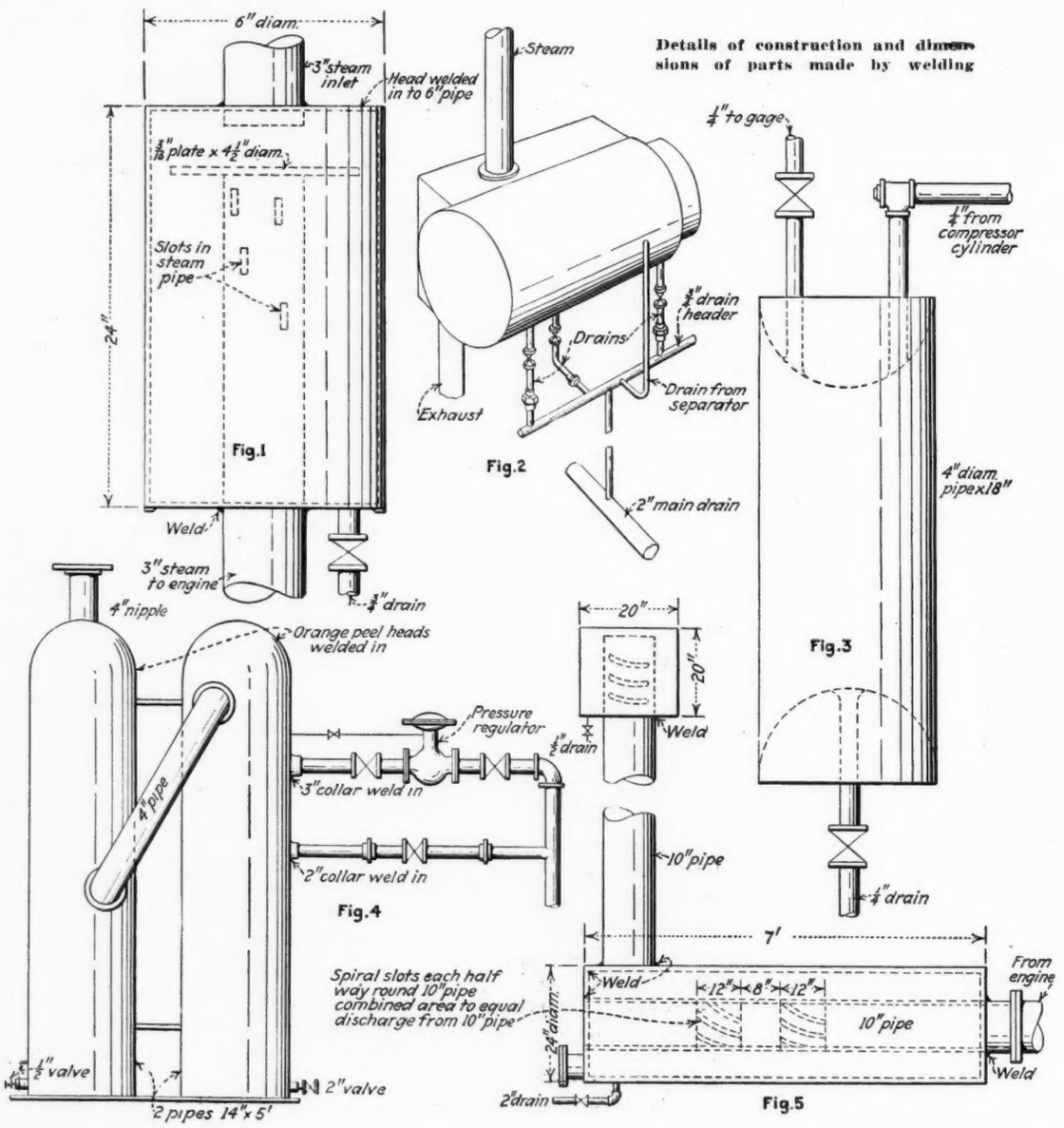
When the compressor is used on gas a scrubber is necessary. A practical type of scrubber can be made up from two 14-in. pipes 5 ft. long, as shown in Fig. 4. These are welded on a piece of ¼ plate, with 6-in. spacers between them. The heads are of the "orange peel" type, and in one a 4-in. nipple is welded. In the side of the other a 2- and a 3-in. coupling are welded. The 3-in. connection should be about 2 ft. 6 in. from the floor. The two tanks are connected by a 4-in. pipe welded on diagonally as shown. In operation, it will be found that the sand and grit are deposited in the first section and the water and oil in the second. This has been found to be a most efficient type of scrubber for use with a small compressor. It can be made up on the job and the design can be modified to suit conditions.

In a gas-engine-driven type of compressor of larger size, that is, around 100 hp., a muffler is necessary and can be made up as follows:

The shell is rolled from plates ¼ in. thick into a cylinder 24 in. in diameter and welded up the seam. Flat heads are also welded in the ends. A 10-in. pipe is then flanged at one end, and is inserted through one head and welded in place. Previous to doing this, spiral slots are cut in to equal the area of the pipe. A 10-in. uptake is welded in the top of the shell. This pipe is fitted with a head on the discharge, as shown.

In certain classes of work where piping has to be joined it is usual to have Vanstone or similar types of flanges fitted to the pipes. These are then welded in place in the field. As this type of flange is loose on the pipe it can be turned to suit the opposite companion flange, which in the case of large pipe is very convenient. Where a reduction in pipe size has to be effected it can be quickly done by slotting the pipe with a torch and then bending in the pieces until the desired reduction has been obtained. This is welded to the smaller pipe and makes a neat and satisfactory reducer.

Arcadia, Calif. M. C. COCKSHOTT.



From Among Readers' Problems

Conducted by
L. H. MORRISON

SLIPPAGE OF RIVETED JOINT OF BOILER—*Is slippage of a riveted boiler joint an indication that the joint has been stressed to the point of failure?* F.M.

In a newly constructed joint the resistance to initial slippage consists mainly of friction between the plates due to the longitudinal shrinkage of the rivets from cooling after they are driven. Some displacement of the plates must occur before the sides of the holes are brought to a bearing to exert a shearing action on the rivets, because the rivets in cooling also contract in diameter and do not completely fill the rivet holes.

The friction between the plates is uncertain and the strength of riveted joints is based on resistance to stresses concomitant with shearing action on the rivets; and sufficient slippage for taking up bearings on the rivets that have been properly driven is only an indication that the rivets are in position for receiving the shearing stresses, and not that the joint has been overstressed.

BENDS IN ELEVATOR ROPES—*In the diagram the roping of a full-wrap traction elevator is shown. The ropes lead from the car over the traction sheave, around under the secondary sheave and again over the traction sheave to the counterweights. How many bends do the ropes make around the sheaves, during one trip, for the full length of the hoistway?* C.B.G.

The answer depends upon what is meant by a bend. In the diagram the hoisting ropes lead from the car over the driving sheave around the idler sheave, and again around the driving sheave. In each case the ropes make a 180-deg. bend, and in one trip of the car the ropes bend three times around the sheaves.

Another way of considering this: When the ropes bend over a sheave they assume an abnormal form. Therefore, one bend is put into them as they lead on to the sheave. When the ropes lead off the sheave they bend to normal position. When the ropes lead on to the sheave they bend to conform with the curvature of the sheave, and when they lead off the sheave they again bend from the curvature of the sheave to a straight section. From this point of view, the ropes bend six times as they pass around the driving and idler sheaves, instead of three times.

Another way of looking at the proposition is to consider the changes of condition in the ropes. When the ropes lead on to the sheave their condition is changed from that which existed when they were straight to that prevailing when they are curved. When the ropes lead off of the sheave, the condition in the rope is again changed from that which exists when they are curved around the sheaves to that which prevails when the ropes are straight.

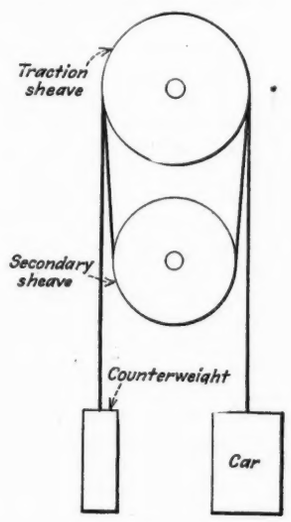


Diagram of full-wrap traction elevator roping

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

OUR uniflow steam engines are supplied steam at 150 lb. gage. It is now planned to build a new boiler house and install additional power in the shape of a steam turbine. Will we have difficulty if the uniflows are supplied with steam at 300 lb. pressure and 100 deg. superheat? S.W.M.

THE QUESTION is identical with that which arose in the plants with which I am connected. It was answered by obtaining the experiences of certain plants operating engines at high pressure and superheat. While there are numerous uniflow installations of comparable pressures and temperatures, nevertheless it appears that certain difficulties, chiefly in lubrication, will usually be encountered, especially if there is any tendency for boiler "carryover" into superheaters, and if the piston speed is over 800 ft. per minute. In fact, reputable manufacturers of uniflow engines insist that the steam be clean before agreeing to furnish engines for high temperatures. The trouble-free dead line is somewhat below the 300 lb. pressure and 100 deg. superheat mentioned.

It will require changes in the engines and will cost considerable to adapt them to the new conditions.

My opinion is, therefore, that since a trouble-free installation with the same economy and at possibly no greater cost may be had with a bleeder turbine-engine combination, it is preferable not to use steam at 300 lb. and 100 deg. superheat directly in the uniflow engines.

LEWIS J. SFORZINI.

Rochester, N. Y.

FIRST change the steam line that delivers steam to the unit. The line of pipe that was designed to deliver saturated steam at 150 lb. will no doubt be too light in weight to give the proper strength for safety at 300 lb. and 100 deg. superheat. The expansion per lineal foot of pipe will be much more and this will have to be taken care of by expansion bends or expansion joints. Expansion bends in the pipe line is the best practice.

The steam receiver or separator placed ahead of the throttle valve would also be too light in design and should be changed. Possibly calculations will show that a much smaller separator as well as a smaller steam line will deliver the right amount of steam to this unit when it is changed from 150 to 300 lb. pressure.

Next, replace the cylinder, including

valves, piston, throttle valve, with cast-steel parts. This change should be made by the maker of the engine. He should also take care of packing trouble by placing the proper metallic packing on rods and valves and redesign the method of lubricating the cylinder walls for this temperature and pressure. In fact, the manufacturer should be asked to take care of all details of the change.

As the changes will run into a large per cent of the cost of the unit, I believe a much more reasonable cost can be achieved by changing the steam from 300 lb. back to 150 lb., using a desuperheater and reducing valve. This would allow the steam unit to remain exactly as it is now. The steam piping from the desuperheater to the superheater header would, of course, have to be changed.

Lawton, Okla. L. HANSEN.

UNIFLOW ENGINES have been designed for reasonably high pressure and superheat and have given lasting and efficient service. No doubt the uniflows in question would have operated successfully at a pressure well above 150 lb. when installed.

Probably the biggest problem, mechanically, of operating a steam engine with high pressure and superheat, is to overcome steam-valve failure. Most valves need plenty of lubrication. High pressure and superheat add to that problem, and the higher pressure increases the surface pressure and friction. No doubt the valves of the uniflow are some form of popett and should give little trouble because of the added pressure and heat, but I would consult a reliable lubricating engineer.

With the higher pressure the engine will cut off sooner for a given load and it might cause unbalance and poor governing. If practical, this might be overcome to a certain extent by adding load or increasing the engine exhaust pressure or both.

But why not install a bleeder or back-pressure turbine that would bleed off or exhaust at the desired pressure to operate the uniflows? S. B. CONKLIN.

Baldwin, N. Y.

THIS question should be taken up with the maker, as the engine may have been designed for a maximum pressure of 150 lb., or even less if an old one.

Granted that the factor of safety of the weakest part is sufficient, and most engines of this type built in recent years are safe for 250 lb., there is no objection if proper lubrication is used. Steam at 300 lb. pressure has a temperature of about 420 deg. F. when saturated, and 100 deg. of superheat will bring this up to 520 deg., so a suitable lubricating oil should be selected.

Should a maker decline to guarantee the engine for 300 lb. pressure, then a reducing valve should be placed between the header and the cylinder.

L. R. BAKER,
The National Acme Co.
Cleveland, Ohio

IT WOULD BE unreasonable to expect an engine designed for a working pressure of around 150 lb. per square inch to take steam at 300 lb. pressure without some changes in the engine cylinder. The maximum stresses or thrusts in the engine frame, rods, cranks, and bearings are determined by the initial pressure, not by the mean effective pressure, regardless of the engine load, in any automatic cutoff engine.

Without any changes, a reducing valve should be used in the steam line to reduce the pressure from 300 lb. to the maximum allowable engine pressure, which may be slightly in excess of the 150 lb. pressure now used, depending upon the manufacturer's specifications and the age of the unit. The steam temperature in this case should not be objectionable in a high-class engine, although it may call for a slight increase in cylinder lubrication over present operation, if the steam is now at saturated temperature.

If space will permit, the uniflow engines may be converted into tandem-compound units by the addition of suitable high-pressure cylinders and valve gears, and in this way adapted to any steam pressure and temperature that may be considered. The tandem-compound engine arrangement will reduce the initial stresses in the frame, rods, crank, etc., to less than those occurring at 150 lb. pressure. This plan also will permit of carrying increased continuous load with equally smooth running performance. Under this arrangement the steam rate of the compound engine operating at 300 lb. pressure will be from 15 to 25 per cent lower than any proposed turbine of equal capacity.

It would appear that the proposed increase in steam pressure is intended to secure better economy in power generation; if so it would seem advisable to investigate the possibilities of converting the present units into compound engines, or the purchase of new units of the reciprocating type to use efficiently the proposed higher steam pressure.

JOHN F. FERGUSON,
Ferguson Engineers.

Chicago, Ill.

IF NO SPECIFICATIONS of the uniflow engines are available as to the pressure for which the engines were built, and also the economical steam rate, I would recommend that such information be obtained from the builder, also the most economical pressure and possible superheat for which the engines were designed, bearing in mind that the average load conditions, including the maximum load, should be ascertained, either with steam engine indicators or, if the engines are connected to generators, with an indicating wattmeter. In case the generators are direct-current, the load can be determined with volt- and ammeters.

After this information is at hand, very likely it will be necessary to install a reducing valve and a desuperheater of proper dimensions on the branch steam lines to the engines. Assuming that the new steam turbines are well selected as to performance and that the exhaust steam from the uniflow engines can be properly used for heating of other process work, the installation of reducing valves and desuperheaters will make a flexible equipment when completed. If the uniflow engines are running condensing, the above recommendations are also in order. In addition, it will be necessary to install a safety valve of proper dimensions on the reduced pressure side to protect the uniflow engines from overpressure.

WILLIAM HAUSER.

Brooklyn, N. Y.

THE TYPE of uniflow engine is not stated, but I would say that the usual uniflow is designed for a maximum pressure of 200 lb. per square inch and a maximum temperature of 550 deg. To operate at 300 lb. would mean an increased thrust of 50 per cent against the crankshaft and frame. I do not believe the engine would operate quietly at this high bearing pressure and piston thrust, in view of the very early cutoff that prevails in the uniflow.

I believe, however, that the pressure on this engine can be raised from 150 to 200 lb., and, by reducing the engine clearance, a substantial reduction in steam rate will be secured.

Reduction of piston area in some way, or a larger crankshaft, would be a rather expensive way of making high pressure possible, and I do not recommend it, unless conditions arise which demand a new cylinder anyway.

Springfield, Mass. A. F. SHEEHAN.

A Question for Our Readers

IN A certain steam-electric plant the "boiler make-up water" is computed and reported as the difference between the total water brought into the system and the known losses. The latter include all blowdowns and water used to refill boilers after they have been drained.

A discussion of the usual method of reporting make-up water is requested. The above method gives a figure more favorable to the plant than would be the case if the actual total were used, and the writer contends that for comparison between plants it would be better to report all water actually brought into the system. R.F.H.

Suitable answers from readers will be paid for and published in the June 3 number.

High Pressures and Temperatures

For Steam Prime Movers

By O. WIBERG
Chief Engineer Stal Turbine Co.
Fingspong, Sweden

The relation between the physical properties of various metals and the improvement in thermal efficiencies possible by increasing steam pressures and temperatures is shown by curves presented in this article, which is an abstract of a paper presented at the World Power Conference, Tokio.

THE thermal efficiency of a heat engine depends chiefly upon the available range in temperatures, so the temperature of the heat-containing medium at the inlet and the discharge should be as widely separated as possible. In the steam turbine field there has been a pronounced movement in recent years to improve thermal efficiencies by employing higher pressures and temperatures.

There are no material difficulties in designing steam plants for the pressures used so far. When increasing the temperature, however, a very marked limit, rather difficult to exceed, is soon reached, because the physical properties of the materials usually employed in steam plants are found to change considerably when they are exposed to high temperatures. Ordinary high-grade materials used in steam turbines are thus found to have their physical strength gradually impaired at temperatures above 570 deg. F., which fact considerably reduces the possibility of utilizing very high steam temperatures.

At high temperatures, materials behave in a manner resembling that of viscous fluids — that is, deformations continue for long periods of time. There is a certain stress at which creepage will start after a certain time for each material and temperature. This stress is defined as the creep limit.

When selecting a high admission pressure, without the possibility of utilizing the necessary high temperatures, a double disadvantage is encountered. First, the highest thermal efficiency resulting from a higher temperature cannot be reached; secondly, because of the relatively low initial steam temperature, wetness at the exhaust will be large. This increased wetness involves not only a lower thermal efficiency, but also an increased erosion on blades and guide vanes. If materials that were available, permitted a considerable increase in steam temperature for the higher pressures, there should be no real difficulties in building a combined high-pressure and high-temperature steam plant which would be just as ready to start and as sensitive to load-changes as an ordinary low-pressure plant without reheater.

To obtain suitable materials for use in steam turbines at elevated temperatures a series of tests were started some time ago, the principal object of which was to obtain figures that would permit comparison between the various materials with regard to their behavior at elevated temperatures.

It would lead too far to give a description of the testing apparatus used for this investigation, and I shall confine myself to making brief descriptions of the results that have been obtained.

Among the materials tested, the following were selected for comparative purposes:

1. Carbon steel with 0.15 per cent carbon, normalized at 1,688 deg. F.
2. Carbon steel with 0.50 per cent carbon, normalized at 1,526 deg. F.
3. Martensitic chromium steel (0.35 per cent C., 13.5 per cent Cr, hardened at 1,697 deg. F. in oil and tempered at 1,130 deg. F).
4. Austenitic chromium steel (Krupp V2A).
5. Austenitic chromium steel (Firth Crown steel).
6. Heat-resistive alloy (15 per cent Cr, 6 per cent Ni, 7 per cent Mo, 15 per cent Fe, 2 per cent Mn), (Heraeus B7M).
7. Heat-resistive alloy (15 per cent Cr, 64 per cent Ni, 20 per cent Fe, 1 per cent Mn), (Heraeus B).

They were submitted to the following tests at various temperatures:

(*a*) Short-time tensile-strength tests. Continuously increasing load from zero to ultimate tensile strength in stages of

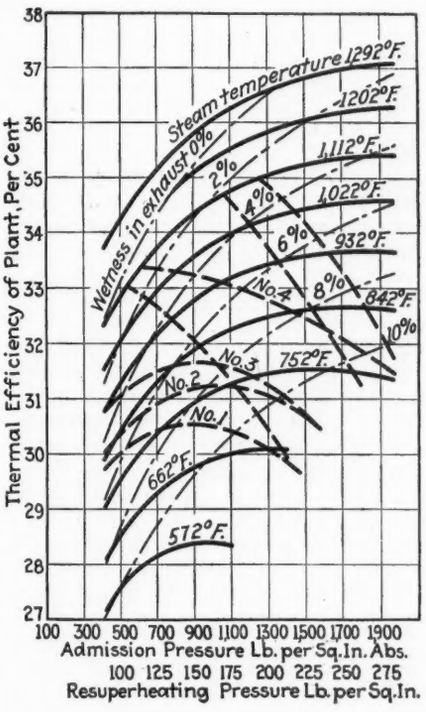


FIG. 1—RELATION BETWEEN THERMAL EFFICIENCY AND LIMITING STEAM CONDITIONS FOR VARIOUS SUPERHEATER TUBE MATERIALS

Assumptions: Turbine size, 50,000 kw.; three-stage feed heating, exhaust pressure, 0.035 atm. (about 29-in. vacuum); permissible stress, 50 per cent of limiting creep stress; boiler efficiency, 87 per cent.

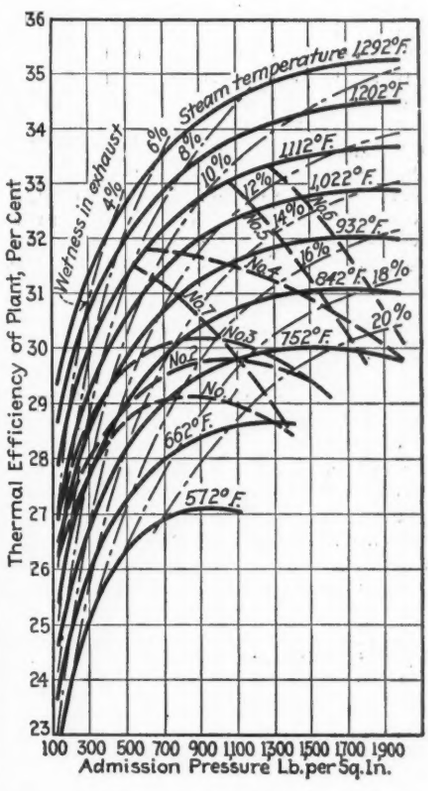


FIG. 2—RELATION BETWEEN THERMAL EFFICIENCY AND LIMITING STEAM CONDITIONS FOR VARIOUS SUPERHEATER TUBE MATERIALS

Assumptions same as in Fig. 1, except one-stage resuperheater included.

1 kg. per square millimeter (1,423 lb. per square inch) every two minutes.

(*b*) Creeping tests at constant load and constant temperature.

(*c*) Fatigue tests with pulsating load.

(*d*) Fatigue tests with alternating load.

The relative importance of these properties at various temperatures must be considered when utilizing the materials in power plant design.

In the analysis, the permissible stress has been set at 50 per cent of the pulsating fatigue limit for the lower temperatures, and 50 per cent of the creep limit for the higher temperatures. The boundary between the temperature regions occurs at a temperature where the

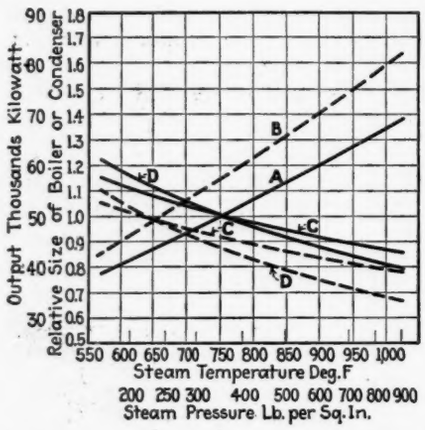

Output Thousands Kilowatts
Relative Size of Boiler or Condenser
90 80 70 60 50 40 30
1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5
B
A
D
C
C
D
550 600 650 700 750 800 850 900 950 1000
Steam Temperature Deg.F
200 250 300 400 500 600 700 800 900
Steam Pressure Lb. per Sq. In.

FIG. 3—VARIATION OF OUTPUT (CURVES *A* AND *B*); BOILER SIZE (CURVES *C*), AND CONDENSER SIZE (CURVES *D*) WITH STEAM CONDITIONS. DOTTED CURVES FOR THREE-STAGE FEED HEATING

Percentage leaving loss and wetness in exhaust are constant.

stress limit is the same from the two points of view.

Calculation has been carried out for a superheater tube, this being one of the most exposed parts in a high-pressure plant. The following data have been assumed: inner diameter, 2 in.; wall thickness, 0.15 in.; normal temperature of tube equal to steam temperature, plus 104 deg. F. for temperature drop between tube and the steam, with 77 deg. F. as a safety margin.

Fig. 1 shows the thermal efficiency as a function of the admission pressure at various temperatures. As a basis for this diagram there have been selected the efficiency ratios of a 50,000-kw. turbine of the most economical type on the market. Three stage preheating is assumed, and all losses, including boilers, turbine, generator, preheater and auxiliaries for turbine and boilers, are taken into account in the heat consumption. A condenser pressure of 0.035 atmospheres (about 29-in. vacuum) is assumed. Under these assumptions there have been drawn curves for each material indicating the pressure that can be allowed for each temperature. The diagram shown in Fig. 2 is drawn on a similar basis and shows the efficiency obtainable by re-superheating.

It is worthy of note that the general shape of the two curves for the carbon steels No. 1 and No. 2 and the chromium steel No. 3 is fundamentally different from that of the other materials. The former gives a fairly well-defined point of maximum thermal efficiency, whereas the latter gives increasing thermal efficiency for decreasing admission pressures. This is due to the superior qualities of the latter materials at elevated temperatures.

This conclusion is correct for the detail in question, a superheater tube, and similar elements; but when we consider the parts of the turbine proper, particularly the rotating elements, there is another feature which must be considered. That is the total amount of residual deformation at the specific load applied. Thus, for turbine elements, where only very small creeping deformations can be allowed, it ought to be advisable to select a higher factor of safety at elevated temperatures.

WHEN using materials of the type indicated by curves No. 1 to No. 3 it will be found that a maximum of thermal efficiency is reached when using an admission pressure of, say, 850 lb. However, for material No. 1 this admission pressure corresponds to a steam temperature of 716 deg. F., which gives a wetness of about 17 per cent. Thus, if the maximum wetness is to be restricted to about 12 per cent, it is necessary to select a higher temperature and, consequently, a lower pressure. This gives for material No. 1 a temperature of 824 deg., and a pressure of 400 lb.

However, this is accompanied by a loss in thermal efficiency of about 0.8 per cent that is, the heat consumption is increased about 3 per cent. Especially for carbon steels oxidation also has to be taken into account. For example, carbon steel No. 1 shows scaling above 842 deg. F. when exposed to normal furnace atmosphere or in superheated steam. Considering material No. 3, a wetness of 12 per cent demands an admission pressure of 595 lb. and a temperature of 895 deg. F., with a decrease in thermal efficiency of about $\frac{1}{4}$ per cent below that corresponding to the most efficient admission conditions for the material in question. This steel is also comparatively more resistant to oxidation. Regarding material of the austenitic structure, conditions are more favorable to utilizing high temperatures.

CONSIDERING again material No. 7, it will be seen that the point of maximum thermal efficiency lies at a temperature which for many reasons cannot be considered at the present time. The tests for these materials have been carried to 1,290 degrees.

It is not implied that the turbine makers at the present time are ready to go to an admission temperature of 1,130 deg., but the curves have been extended to this point to illustrate the tendency. Whether it is possible to contemplate an extension of admission temperatures up to this region is a metallurgical question, which must be studied further. As the austenitic materials, although possessing desirable tensile strength at high temperatures, give very large deformations before the creep limit is reached, their application to turbine parts at very high temperatures is questionable.

It must be pointed out that the materials showing the highest qualities at elevated temperatures are causing considerable difficulties in tube manufacturing. Therefore, the development necessitates a parallel perfection of tool materials.

Considering lastly the question of utilization of power plant equipment, I wish to refer briefly to Fig. 3. Curve *A* shows the amount of power that can be generated by one condensing turbine at constant percentage of discharge losses, and at various pressures and temperatures. Curve *B* shows the corresponding relationship for three-stage feed heating. Curves *C* and *D* show the corresponding size of boiler and condenser, respectively.

Consider, for example, a 50,000-kw. turbine operating with three-stage heating at 660 deg. and 240-lb. pressure. If the temperature is increased to 840 deg. and the pressure to 500 lb. the same turbine will develop 65,000 kw. The relative size of the boiler is reduced 12 per cent and the relative size of the condensing plant is reduced 19 per cent. This considerable increase in utilization of the plant is sufficient to justify great efforts toward further utilization of higher temperatures and pressures.

Hydro Power Progress in New Zealand

IN THE course of a notable lecture delivered in London recently before the Royal Geographical Society on the subject of hydro-electric power development in New Zealand, R. Ogilvie Buchanan declared that this development had been considerable since the war, during which time the installed horsepower had increased from 49,000 in 1919 to 149,000 in 1927. Within the last few months the first stages of two new stations have been put into operation, adding a further 90,000 horsepower.

In comparison with the power production of Canada, for example (5,300,000 hp. in 1928), this seems trifling, yet it represents a production of 0.17 horsepower per capita, which is exceeded by only four countries—Norway, Sweden, Canada, and Switzerland. It is, too, a very small fraction of New Zealand's potential power. Two comprehensive inquiries have been made as to New Zealand's resources in this respect. The first, in 1904, estimated the total, neglecting sources of under 1,000 hp., at 3,700,000 hp., of which the South Island's share was 3,200,000. Another report, in 1918, put the total at 4,870,000 hp., of which the South Island accounted for 4,100,000. This represents a potential power of 3 hp. per capita, an allowance greatly in excess of the utmost that is likely to be utilized for a long time to come.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Self-Contained Deaerating Heater for Buildings and Industrial Plants

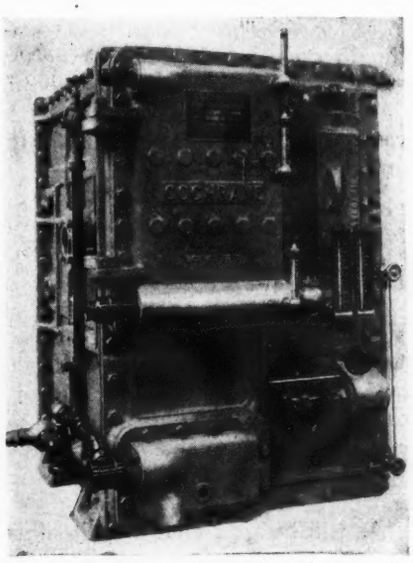
IT IS now generally well known that where pure or soft water is heated and circulated through iron piping, corrosion takes place unless all traces of the dissolved oxygen have been removed from the water. Trouble from this source, known as dezincification, occurs in brass piping carrying hot water containing any appreciable amount of oxygen. To eliminate this trouble in hot-water service and heating systems in office buildings, hotels and industrial plants generally, the self-contained deaërator illustrated has been brought out by the Cochrane Corporation, Philadelphia, Pa.

As conditions in buildings of this kind are much different from those in power plants, where deaërators have been used successfully for some years, a special type of unit is used. The process of eliminating the oxygen by use of the deaërator illustrated comprises the following steps:

1. The water is heated to the temperature at which it boils under the total pressure of the atmosphere actually in contact with the water.
2. The water is spread out by distribution over trays and is agitated for a time, thus increasing the area of the liberating surface from which gas may escape.
3. The atmosphere in contact with the water is continually removed and replaced by pure steam to carry away the liberated gases through a vent.

Referring to the flow diagram, the raw cold water first enters the vent condenser, from which it passes through a tubular preheater to the control valve, thence flowing on to deaërating trays in the upper part of the shell, dropping from the latter into the storage space of the heater.

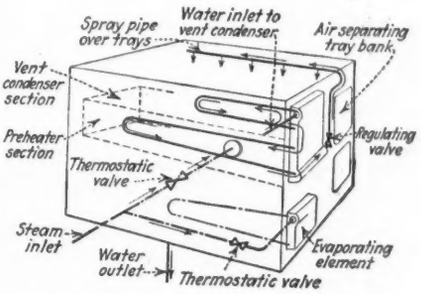
The steam enters the preheater through a valve controlled by a thermostat subject to the temperature of the water leaving the preheater. It also enters the evaporator coil, located in the storage space, through a valve controlled by a thermostat bulb. The steam admitted to the evaporator being hotter than the water in the storage space, generates steam from the latter, which rises through the trays over which the heated incoming water is flowing, sweeping out the gases liberated from the water. The mixture of air and gases rising from the tray stack passes into a vent condenser, where the steam is condensed and its heat recovered by incoming cold water. Condensate from the vent condenser drains back into the tray chamber, while the gases are drawn off by a vacuum pump or by a stem ejector, the pump being used for low vacuum, and where high pressure steam is not available, the ejector being preferred for high vacuum. If a steam ejector is used, it discharges into the evaporator coil. The preheater and the evaporator are vented directly to atmosphere. Drips from both the preheater and the evaporator are generally returned to the boiler, either by way of a feed-water heater or directly by a return trap or pump.



Deaërating heater

The preheater, which does most of the heating, has eight passes, so that the water is circulated rapidly, advantageous from the standpoint of heat transmission. The function of the evaporator is to supply sufficient vapor to ventilate or scavenge space surrounding the water flowing over the trays.

The shell of the deaërator is built for pressures varying from a complete vacuum up to 10 lb. gage, and standard deaërators are designed to receive water at 40 to 70 deg. F. and to deliver it at 150 to 180 deg. F. for any temperature up to 235 deg. F. There is no piping over the front of the heater, the connections to the water space of the vent condenser being made in one side plate, while the steam connections to the preheater and evaporator steam chest covers are made through unions at one side. The top plate, back plate and one side plate are free of all openings or connections, and the heater may therefore be placed in a corner and against the ceiling and supported on a single structural foundation.

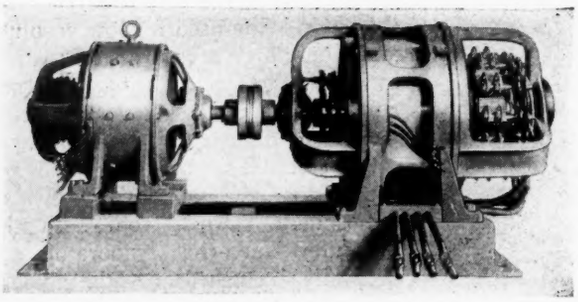


Flow diagram of water and steam through heater

Converters for Low Frequency Currents

FOR OBTAINING frequencies different from those generally available a line of special frequency converters has been introduced by the Reliance Electric & Engineering Company, 1042 Ivanhoe Road, Cleveland, Ohio.

The machines are built for opera-



Frequency converter unit for single-, two- and three-phase circuits

tion on either two or three-phase circuits and to give single,- two- and three-phase current at frequencies ranging from three cycles upward. They can also be used to obtain variations in speeds with squirrel-cage induction motors and to get speeds which are either higher or lower than can be obtained from induction motors operating on a standard frequency.

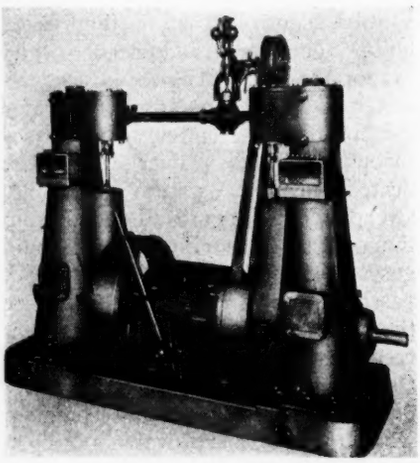
Engines With Adjustable Cutoff and Reverse

AN IMPROVED mechanism for adjusting the cutoff and reversing is incorporated in a line of single- and twin-cylinder engines now being put out by the Engberg Division of the Troy Engine & Machine Company, St. Joseph, Mich.

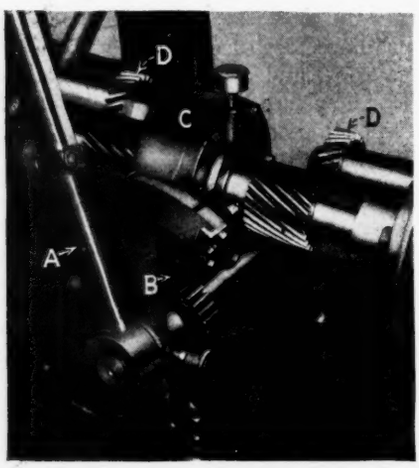
Referring to the illustration of the reversing mechanism, the operating lever *A* is keyed to a horizontal shaft on which are mounted two spur pinions, which mesh with two racks, as at *B*, that are bolted to a ball-bearing housing *C*. The ball bearing is mounted on a sleeve, on the two ends of which are cut wide spiral gears, the sleeve, in turn, being driven by the engine crankshaft through a spline key. Two narrow spiral gears *D* mounted on pins which carry the eccentrics mesh with the wide gears on the sleeve, the whole rotating with the engine crankshaft.

As will be clear from a study of the illustration, any change in the position of the lever *A* changes the lateral position of the sleeve on the shaft and rotates the pins (owing to the angularity of the gear teeth) on which the eccentrics are mounted, thus changing the position of the eccentrics and consequently the cutoff and stroke of the valves.

For reversing engines the center of the quadrant is the neutral position, at which no steam is admitted by the valve. Moving the lever to either side of the neutral point determines the direction in which the engine will run. If the reversing feature is not desired the quadrant is arranged to cover the proper range of cutoffs for one direction of rotation.



Twin cylinder unit with reversing mechanism



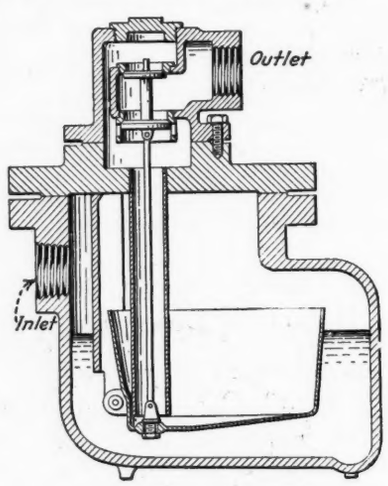
Reversing mechanism for twin cylinder engine

Balanced-Valve Trap Has Large Capacity

EXCEPTIONALLY large capacity at low pressure is an important claim made for the Strong balanced-valve trap illustrated, which is particularly suitable for handling condensation, gasoline, oil, caustics and other liquids.

As will be apparent from the illustration, the double-seated or semi-balanced valve is operated by an open bucket hinged on a bracket extending downward from the cover. For special application other than water the trap is fitted with valve, bucket and other operating parts of material suitable for the conditions involved.

Sizes in which this trap is made are from $2\frac{1}{2}$ to $3\frac{1}{2}$ in., inclusive; operating pressures range from 0 to 50 lb.; and the capacity up to 100,000 lb. of liquid an hour. The trap is put out by the Strong, Carlisle & Hammond Company, Cleveland, Ohio.

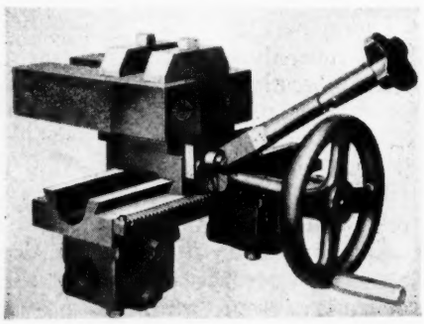


Trap has large capacity at low pressure

Improved Commutator Grinder

TO THE line of commutator grinding and resurfacing equipment put out by the Ideal Commutator Dresser Company, Sycamore, Ill., has been added the "Ideal" grinder illustrated.

This grinder is designed so that it may be used within a space the same length as the base, there being no protuding parts on the side. The cross-feed wheel is in the back, making it possible to use the grinder on commutators having outboard fans or other obstructions.

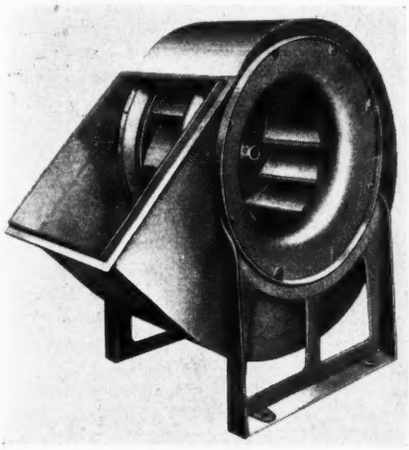


"Ideal" model precision grinder

Streamline Fan for Ventilating Service

HIGH efficiencies over a wide range, a self-limiting horsepower characteristic, a practically linear pressure curve and quiet operation at high speeds (making it possible to use direct-connected standard motors) are important features claimed for the new streamline ventilating fan brought out by the Massachusetts Blower Division of the Bishop & Babcock Sales Company, 4901 Hamilton Ave. N.E., Cleveland, Ohio.

As quiet operation is of major importance in fans used for ventilating, special attention has been given to this point in the design of the new fan. All air passages are free of obstructions, with all edges which cut the air stream well rounded.

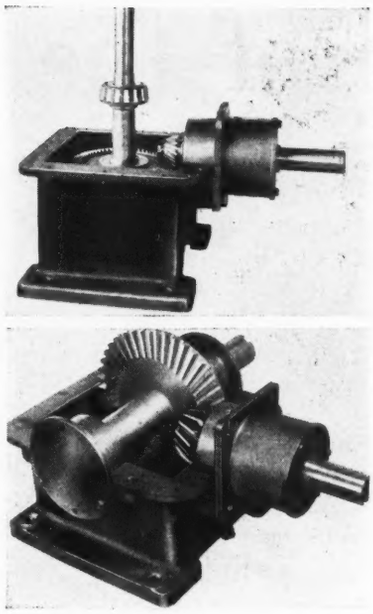


Massachusetts streamline fan

Arc welding has replaced rivets wherever practical in construction of the wheel. A heavy gage plate, flanged and reinforced, is riveted to the hub and forms a rigid disk upon which the wheel is built up. Twelve heavy vanes are arc welded to the disk and also to a conical band at the inlet side. A sheet-metal cone is used in the wheel inlet and is riveted to the back plate. Two types of wheels are available, normal-duty wheels for top speed of 7,000 ft. per minute and heavy-duty wheels for speeds between 7,000 and 10,000 ft. per minute.

Sufficiently heavy gage metal in the sides and scroll sheets of the housing makes angle bracing unnecessary, and a continuous fillet weld the entire length of the joint is used to join the side and scroll sheets.

The fan is made in a number of sizes, ranging in capacities from 900 to 50,000 c.f.m., and for static pressures from $\frac{1}{8}$ to $3\frac{1}{2}$ inches.



Vertical- and horizontal-type speed reducer

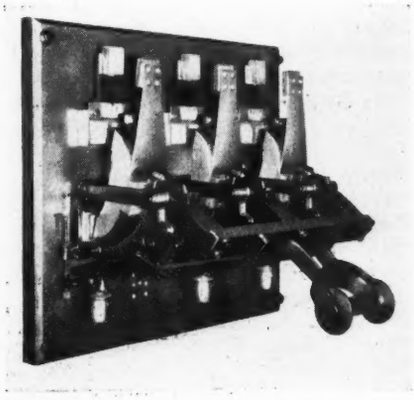
Right-Angle Speed Reducers

MADE in ratings ranging from $\frac{1}{4}$ hp. to 100 hp., with ratios of 1 to 1 to 6 to 1, the new right-angle speed reducers illustrated have spiral bevel gears mounted on roller bearings. The new line includes both horizontal and vertical types, with slow-speed shaft extended either upward or downward.

Larger reductions are obtained by combinations of the spiral bevel gear and planetary spiral gears with ratios of 8 to 1 up to 1,600 to 1. Gear teeth and bearings are splash lubricated. The speed reducers are put out by D. O. James Manufacturing Company, 114 West Monroe St., Chicago, Ill.

Improved Circuit Breakers

TYPE CK - 8 heavy - current breaker, included in a new line of "trip-free" breakers recently brought out by the General Electric Company, Schenectady, N. Y., is illustrated. It is designed for heavy-duty service ranging from 1,600 to 3,000 amp. The line also includes the type CN-1 breaker, applicable to industrial service and to circuits in buildings where the current is from 3 to 300 amp., and type CP-108, suitable for moderate-duty service, rated 1,200 amperes.

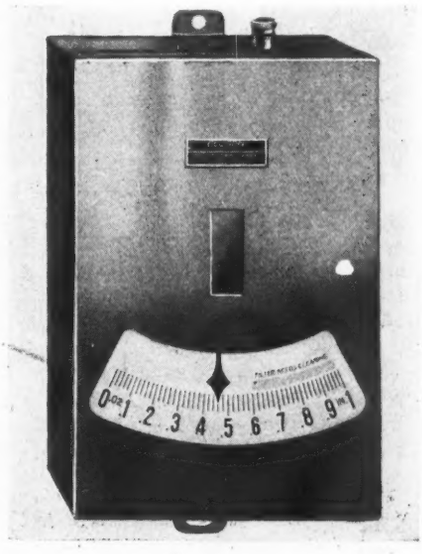


Type CK-8 heavy duty breaker

The principal advantages claimed for these breakers by the manufacturer are: They are trip-free from the handle on overcurrent; there is triple contact; no burning on the main brush; burning tips are easily replaced; high-pressure main contact is formed of laminations which make "end-on" contact with heavy and uniform pressure, and yet is closed easily with a wiping motion; and they have low operating temperature. The breakers are available for either instantaneous or time delay automatic operation.

Air Filter Gage

FOR INDICATING the differential pressure across, or the resistance through, air filters, either of the oil or airmat type, the Ellison Draft Gage Company, of Chicago, has adapted its new differential dial-type draft gage with the double-bell movement to show when the filter needs attention.



Gage especially designed for use with air filters

A clean filter indicates a low resistance by a low reading on the scale. As the filter gradually becomes foul, the pointer moves correspondingly over the scale until a point is reached where the filter needs cleaning.

NEWS of the FIELD

Spot News

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INSISTING *that public service commissions were originally established to see that the utilities furnish consumers with adequate service at reasonable rates and to protect legitimate investors in utility securities, Governor Roosevelt of New York on April 22 vetoed as founded on a false conception the bill creating a people's counsel. He rejected the idea that the commissions are primarily judicial bodies and said that the sentiment for this bill was due to the failure of the New York commission to protect the consumer.*

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AFTER TWO YEARS' STUDY *of the projects incidental to the erection of Boulder Dam, the Colorado River Board of engineers and geologists has reported in favor of increasing the height of the dam by 25 ft. to provide adequate flood control. With this addition the dam would be more than 700 ft. high, with a capacity of 550,000 firm horsepower.*

•

PLANS *were announced April 22 for the addition of two 160,000-kw. turbine-generators to the Hudson Avenue Station of the Brooklyn Edison Company. One machine will be installed next year and the second in 1932. Raising the capacity of the station to 770,000 kw., the new units with boilers and accessories will cost approximately $14,000,000.*

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A LICENSE *has been issued to the Safe Harbor Water Power Corporation covering its large development on the Susquehanna River, and construction work is once more proceeding. The Federal Power Commission declined to insert a condition in the license requiring the corporation to provide a crossing over the river.*

•

POWER COMPANIES *that heretofore have been permitted to use seven frequencies for emergency radio communication between substations when all forms of wire communication fail, are restricted to a single channel under a new general order adopted recently by the Federal Radio Commission.*

A.S.M.E. Oil and Gas Power Meeting at Penn State, June 12-14

Third national conference promises excellent technical program, ample time for recreation and exhibition of oil-engine parts

FOR THE third consecutive year the Oil and Gas Power Division of the American Society of Mechanical Engineers will hold its national meeting at State College, Pa., in conjunction with Pennsylvania State College. Held on June 12, 13 and 14, this year's conference offers a splendid technical and recreational program together with an exhibition of oil-engine parts and accessories that should prove of great interest to engine builders and users. Membership in the A.S.M.E. is not necessary for attendance at the meeting; everybody is welcome.

Technical sessions start on Thursday morning with the presentation of three papers: "Factors Affecting Nozzle Design in the Light of Recent Oil Spray Experiments," by Prof. P. H. Schweitzer, Pennsylvania State College; "Pressure Variations in Common-Rail Fuel Injection Systems," by Addison Rothrock, National Advisory Committee for Aeronautics; and "The Research of the National Advisory Committee for Aeronautics on Aircraft Diesel Engines," by Carlton Kemper.

In the afternoon two reports and two papers will be presented: "Diesel Fuel Standardization Committee Continuing Report," by W. H. Butler; "Diesel Power Cost Committee Continuing Report," by Franz Eder; "Purification of Diesel Engine Lubricating Oil," by Dr. A. E. Flowers, DeLaval Separator Company; and "Operating Results from Diesel Engine Supercharging," by C. A. Lorenzen, New York City.

On Friday morning three papers will be given, as follows: "Diesel Power Plant Layout, With Illustrations From Practice," by E. W. Hammond, Buffalo Works of the Worthington Pump & Machinery Corporation; "Joint Use of Diesel and Steam Engines to Balance Heat and Power," by Edgar J. Kates, consulting engineer of New York City; and "Economics of the Use of Electric Power Generation," by T. A. Burdick, chief engineer of the General Water Works & Electric Corporation. L. H. Morrison, of New York, chairman of the division and an associate editor of *Power*, will be the principal speaker at the annual banquet in the evening, with Dean R. L. Sackett presiding.

Papers to be presented at the sessions on Saturday include: "The Elimination of Torsional Vibration," by George J. Dashefsky, Diesel Engine Section of the United States Navy; "Latest Gas Engine Developments With Special Reference to Activities in California Oil Fields," by Dr. V. L. Maleev, Western Enterprise Engine Company; "The Oil Engine in Aeronautics," by E. E. Wilson, Propeller Corporation; "The Diesel Engine Tractor and Excavator," by C. G. A. Rosen, Caterpillar Tractor Company; "Some Phases of Light Weight Diesel Engine Design," by P. B. Jackson, Aluminum Company of America; and "Future Diesel Progress in the Light of Recent Metallurgical Advances," by C. R. Alden, Ex-Cell-O Aircraft & Tool Corporation.

Some of the latest developments in the field will be shown at the exhibit of engine parts and accessories, which is to be held in Penn State College Armory, directly across the street from Schwab Auditorium, where the technical sessions will be held. The exhibit will be open throughout the course of the meeting for the convenience of those attending.

Two New Hydro Projects for South Carolina

With Saluda Dam nearing completion and the proposal of two new projects, South Carolina's hydro-electric power output will be more than doubled. One of these new projects, the Santee-Cooper canal is already in the process of construction and will call for the building of two dams, one on the Santee River and the other on the Cooper River. These dams will operate two large reservoirs, and by turning the water from the Santee to the Cooper River they will make possible the generation of 235,000 horsepower.

The dam over the Santee River is to be of concrete, while that over the Cooper is to be of earth. The reservoirs will cover approximately 74,500 and 57,700 acres, respectively. This development is expected to be completed within the next four years.

The second of these projects is on the Savannah River, and it will rank with

the Saluda plant in size, amount of power generated and cost of construction. This dam will maintain a lake covering approximately 55 square miles on the South Carolina side of the river, in McCormick County. According to present plans, work on this plant will be started as soon as possible. When completed, the dam will be 90 ft. high and 3,800 ft. long. The project will be constructed of concrete and will involve an expenditure of approximately $20,000,000.

Boiler Drum Fusion Welding Discussed by A.W.S.

Proposed specifications for fusion welding of power boiler drums or shells, notes upon which were published in the March 25 issue of *Power*, were the basis of a lively discussion at the April 23 session of the American Welding Society annual meeting in New York City. F. R. Low, chairman of the A.S.M.E. Boiler Code Committee, presided at the session.

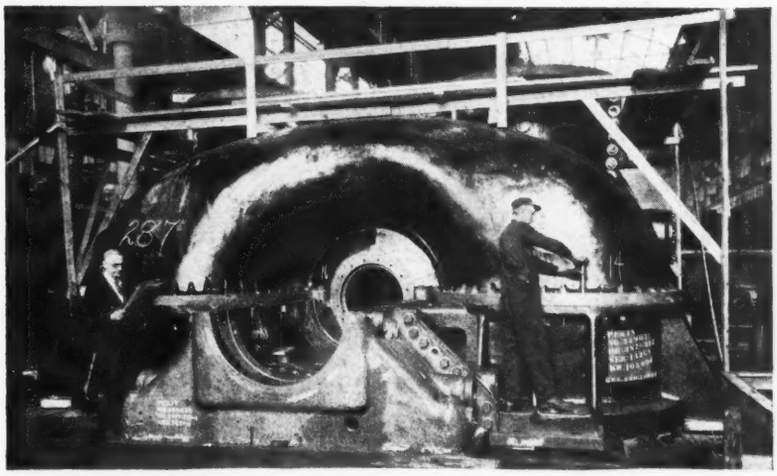
It was pointed out by representatives of the A.S.M.E. boiler code committee that the specifications as proposed by it should be considered from the viewpoint that the A.S.M.E. boiler code committee is primarily a safety committee and, therefore, its regulations must lean toward securing a safe construction from all points of view and regardless of the probability that some welding concerns have advanced their practice far beyond others and so for the moment are at a disadvantage when required to work under a code predicated upon safety of boilers even when built under less advanced technique.

Committee representatives further stated their definite realization that fusion welded vessels will be used in boiler construction and regularly accepted under a suitable code. At the present moment their problem is to determine a proper code, the difficulty in accomplishing this being greatly magnified by the apparent lack of agreement among the welding experts themselves as to what constitutes best practice. In the discussion of the proposed code there were opinions pro and con upon nearly all of the clauses.

The suggestion that test plates for longitudinal joints be attached to the shell and welded as a continuation of it was for the most part not considered effective. Emphasis was laid upon the desirability of using the term "stress relief" as differentiated from the sometimes misapplied term "annealing" with reference to the uniform heating of the welded structure.

The meeting was closed with a request from the representatives of the A.S.M.E. boiler code committee that everyone interested in the problem of forming a suitable specification for fusion welding of drums for power boilers should carefully read the specification already proposed and write the boiler code committee their views and suggestions.

TRIPLE-TANDEM-COMPOUND TURBINE



A NEW TYPE of turbine generator is being built at the Schenectady works of General Electric Company for the Superpower Company of Illinois, at Powerton, Ill. Known as the triple-tandem-compound turbine-generator, it has one electric generator and three steam turbine elements (high, intermediate and low pressure) mounted on a single machine. Two of these units are being built for the Powerton generating station. Each is rated at 105,000 kw., 1,800 r.p.m., 22,000 volts, 600 lb. steam pressure, 725 deg. F. steam pressure, and boiler reheat to 750 deg. between the high and intermediate stages. The photograph shows the generator end of the casing of the low-pressure element of the first of these turbines to be constructed.

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Work on Large Steam Plant Started in Virginia

Contractors for the Virginia Public Service Company have broken ground at New Canton, Va., for the construction of a steam power plant which promises to be not only one of the largest plants in Virginia, but one of the most efficient and scientifically up-to-date of its kind in the world. Work is going forward night and day. It is expected that the first unit of the plant will be operating by Jan. 1, 1931. The plant will be located in the middle of a 100-acre tract just across the James River from New Canton and immediately below the town of Bremo Bluff.

The first unit will have an installed capacity of 40,000 hp., which is to be increased rapidly to 134,000 hp., with a further addition when development in the territory warrants to 267,000 hp. This will be the base load-plant for the entire interconnected system of the company. The cost of that portion now in the course of construction will exceed $3,000,000.

In the first unit of the plant will be two compound turbine-generators of 15,000 kw. capacity each, to be operated at 450 lb. pressure and at an initial temperature of 750 deg. F., with provisions for future operations at higher temperatures.

The single-pass vertical boilers will be fired with pulverized-coal, there being three burners and pulverizers per boiler. The boilers will be equipped with air heaters of a new type and with combustion control for each burner, which will be operated from control board sections of a new and advanced design, differentiating the plant in efficiency from any electric plant heretofore put into operation. Coal will be conveyed to a multiple burner directly over the pulverizers, which are to be of the ball type, running under vacuum to assure operation free from dust.

Enormous Profit Made by Bond & Share

The Electric Bond & Share Company in 1927 made a profit of at least 241 per cent of the cost of the three chief types of service it performs for the companies it supervises, the Federal Trade Commission was told April 23 at a hearing in its investigation of public utilities.

The company received in fees from the supervised companies and in commissions on sales of securities for them in the period from March 15, 1905, to March 13, 1929, a total of $64,652,386, while its expenses for the period were $45,418,587. Other income brought its net earnings up to $93,261,738, or 67.25 per cent of its income, John H. Bickley, commission accountant, testified.

In 1927, he said, the company received a dividend of $148,800 on the stock of the Southeastern Power & Light Company, which had cost Bond & Share $4,795. This was a return of 3,102 per cent on the investment, he said. In 1928 Bond & Share made 200 per cent on Electric Power & Light stock and 2,191 per cent on National Power & Light stock, he said.

Boiler Sales Decline in First Quarter

Sales of all types of steel boilers, with one or two minor exceptions, were less during the first quarter of 1930 than for the corresponding period of last year, according to reports received by the Department of Commerce from 81 manufacturers, comprising most of the leading firms in the industry. The totals for the first three months of 1930 and 1929 were 2,795 boilers of 3,303,161 sq.ft. and 3,583 of 4,007,019 sq.ft., respectively.

New orders for 992 boilers were placed in March, as compared with 881 boilers in February and 1,466 in March, 1929. The following table presents the number and square footage of each kind of boilers ordered for the first three months of 1930 compared with orders for the corresponding period last year:

	Total 3 Months 1930		Total 3 Months 1929	
	No	Sq.Ft.	No.	Sq.Ft.
Stationary				
Water tube	283	1,639,315	312	1,940,282
Horizontal return tubular	210	293,495	285	374,201
Vertical fire-tube	326	107,092	394	114,990
Locomotive (not railway)	52	38,236	58	38,840
Steel heating	1,479	653,916	2,081	1,063,746
Oil country	219	245,794	213	196,467
Self-contained portable	128	87,281	151	98,459
Miscellaneous	36	14,704	33	19,336
Total	2,733	3,079,833	3,527	3,846,321
Marine				
Water tube	33	197,922	29	138,495
Pipe	2	2,236	1	706
Scotch	22	19,873	24	19,934
Miscellaneous	5	3,297	2	1,563
Total	62	223,328	56	160,698
Grand total	2,795	3,303,161	3,583	4,007,019

Work Progressing Rapidly on Diablo Project

The Diablo Dam, built to impound water to operate the new hydro-electric power plant which the City of Seattle is constructing on the Skagit River at Diablo, is expected to be completed next September, Winston Brothers, contractors, have announced. Completion of the dam will absorb virtually one-half of an appropriation of $13,500,000 recently approved by the city council to finance a five-year development program for the city lighting department. It will enable the city to operate to capacity its present Gorge Creek power plant, a few miles down the river from Diablo, while waiting for the new Diablo plant, J. D. Ross, city light superintendent, has stated. Two electric generators for the new Diablo power house, and the water turbines to operate them, rated at 85,000 hp. each, were ordered recently for delivery early next year. These will double City Light's present production of electricity. Bids for construction of the power house will be called soon. With its equipment, it is estimated to cost between $3,000,000 and $3,250,000.

The power tunnel, through which water will be brought to this plant from back of the Diablo Dam, soon will be finished at a cost of about $750,000 under a separate contract by Rumsey and Jordan. Construction has already been started also on a complete new transmission line, to extend from Diablo into Seattle, at an estimated cost of $2,800,000.

Plans are being made to follow completion of the Diablo development with construction of a control dam at the junction of Ruby Creek and the Skagit River, about six miles above Diablo.

Study Passamaquoddy Tides

An investigation of the movement of tides in Passamaquoddy and Cobscook Bays is provided in a joint resolution passed by the House of Representatives April 21. Canada is to participate in the investigation. Half of the costs, or $45,000, is to be paid by the United States. The passage of the measure was urged by Representative Nelson of Maine, who told the House that the proposed hydro-electric project would provide employment for 5,000 men for four years and would make available 3,000,000,000 kw.-hr. of energy annually. He stated that the interests behind the development already have expended $350,000 in preliminary work but that the effect of the development on the fish industry must be ascertained definitely.

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Easter Eggs

EASTER in Washington is a time to be talking about eggs and egg rolling. Senator Frazier dwelt on this theme in a recent floor speech concerning the Flathead power project. But it was hen eggs, not rabbit eggs, and they were thrown, not rolled.

A few weeks ago, a lady clerk in the Federal Power Commission became enraged at her superior, the chief clerk. She had some eggs handy and hurled them one by one. The eggs were good and so was her aim. She is not working there any more.

Senator Frazier says this was just her way of protesting against "power trust" influence. Letters referring, for example, to power company moves to put Paul Clapp or F. E. Bonner in as executive secretary were removed from the files against her protest, the North Dakota Senator declaimed, she knew too much; interests wanted her away from there, according to the story. Other matters were dragged into the light showing that life on the commission is not a happy one.

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News of Canada

Beauharnois construction gets under way — New holding company formed — West Kootenay alters plans — B.C. water levels again normal

THIS season's program of construction work has already begun on the new Beauharnois power and navigation canal. Exceptionally favorable weather conditions have been responsible for the early start on the work. A little better than a third of the excavation for the power house and for the tail race will be completed this year. The rock excavation at this point will be handled by the largest shovel in the Dominion. It handles eight cubic yards in each bucketful.

The construction railway line, on which will operate 15 locomotives and 80 dump cars, will have its trackage extended this year to more than 25 miles. Other construction work includes the diversion of the St. Louis river, which flows for some distance on the route of the new canal, and also excavation of a new small feeder to provide a less variable flow in the St. Louis River. Altogether, the corporation's dredging equipment will handle something over 7,000,000 cu.yd. of material this season. This compares with some 22,000,000 cu.yd. required to complete the first 200,000 hp. installation in the power plant. By reason of the quantities which have to be moved, Beauharnois power will be able to reduce costs by the use of equipment of a magnitude not hitherto witnessed on construction jobs in the dominion.

FORMATION of Middlewest Utilities Company of Canada, Ltd., was announced recently by Middlewest Utilities. The Canadian subsidiary is to have a capitalization of 50,000 shares preferred and 500,000 shares of common stock, none of which will be publicly offered at this time.

The official announcement said Middlewest of Canada was acquiring interests in existing operating utilities in addition to the Great Lakes Power Company, which it controls along with Algoma District Power Company and National Utilities Company.

Officers of the new company are the same Insull group which controls Middlewest Utilities.

A RADICAL ALTERATION in the plans of the West Kootenay Power & Light Company, Rossland, B. C., for its proposed hydro-electric power development on the Pend Oreille River is indicated in its formal application filed recently with the British Columbia provincial government. Instead of the one 350-ft. dam originally planned, two dams are proposed, one 165 ft. high, at Seven Mile Creek, and another 150 ft. high at Cedar Creek farther down the river. It is considered likely this change will reopen the long-drawn-out fight for water power between the West

Kootenay company and the Reeves-McDonald mining interests. Authority to make surveys was granted to the West Kootenay company early in the year, on the condition that it agree to supply power to the mining company.

FURTHER HEAVY RAINS on the Pacific Coast have put an abundance of water behind the dams of British Columbia Electric Railway Company's power plants. Early in April there was the equivalent of approximately 90,000,000 kw.-hr. in storage in Lake Coquitlam, Stave Lake and Alouette Lake, and the full effect of the recent rains and mild weather has not yet been felt. At the same time in 1929 there was only water for 29,000,000 kw.-hr. in storage, this abnormally low level being the cause of the power shortage later in the same year. Water levels this year are now considered to be normal for this time of the year.

A.S.M.E. Discusses Deepwater In Philadelphia

A paper on the design and construction of the 1,400-lb. Deepwater station was presented before the Philadelphia section of the A.S.M.E. on the evening of April 25 by K. M. Irwin, mechanical engineer, of the United Gas Improvement Company. At the same meeting Mr. Irwin was elected chairman of the section for the ensuing year.

More than 200 members of the section and visitors listened to the presentation and saw moving pictures and slides tracing the construction of the Deepwater plant. While most of the facts presented had already been published, some new points were brought out, particularly in the discussion.

Mr. Irwin stated that the location of the duPont plant near a strategic point for supplying the growing load of Atlantic City and northern New Jersey was an important factor in this new development, which combines the advantages of large-scale central-station power production with full utilization of byproduct power from steam supplied to the industrial plant.

A feature of the plant is the use of 75,000-volt submarine cables laid in a trench across the Delaware River and back-filled to prevent damage by ships' anchors. Particular stress in the paper and the discussion was laid on the use of carbon bottoms in slagging furnaces to prevent erosion. Preliminary experience indicated a great future for this type of construction, several speakers pointed out.

Mr. Irwin emphasized the fact that the duPont turbine was always to be loaded to meet the process-steam demand, the difference between the duPont electrical load and the power generated by this turbine passing freely to or from the utility lines as necessary. Make-up power taken by duPont is paid for at generating cost, while excess power turned into the utility lines receives a credit based on the net value of the heat thereby saved.

Coming Conventions

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual meeting at Skytop Lodge, Cresco, Pa., May 26-28. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Order of Steam Engineers. Annual convention and mechanical exhibit at the Grand Fraternity Building, 1626 Arch St., Philadelphia, Pa., June 9-12. Secretary, William S. Wetzler, 6033 Jefferson St., Philadelphia, Pa.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 19-20. Secretary, Dorothy Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Chattanooga, Tenn., June 17-19. Secretary, C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio.

National District Heating Association. Annual convention at the Coronado Hotel, St. Louis, Mo., June 3-6. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Professor Lockwood Dies; Was Fuel Expert

After an illness of several days, Prof. Edwin Hoyt Lockwood of Yale University, one of the foremost mechanical engineering experts in the country, died April 17 at the New Haven Hospital of heart disease.

He was born Oct. 31, 1865, in New Canaan, Conn., and was educated in public schools and at the New Canaan Seminary, before entering Yale. He was graduated from the Sheffield Scientific School in 1888 with the degree of Ph.B., and for a year afterward was a mechanical draftsman in special machinery for the Diamond Match Company's experimental plant in this city.

In 1890, he returned to Yale for further study in the Sheffield Scientific School and became an instructor in freshman mechanical drafting. In 1892 he received his M.E. degree and in 1901 his Ph.D. degree. In 1900 he was made an assistant professor of mechanical engineering and in 1924 an associate professor in that subject. In 1927 he was appointed high professor of mechanical engineering.

During his long career on the Yale faculty he had taught nearly every subject in mechanical engineering, and had become known throughout the country for his important investigations on fuel combustion in power and heating.

Obituary

DR. HARRY HARTSHORNE SEABROOK, for nearly 25 years president of the Nason Manufacturing Company of New York City, died suddenly on April 9 at his home in that city. He was 70 years old. Born in New Jersey and educated as a physician, Dr. Seabrook became interested in the Nason company through his marriage to Miss May Nason, daughter of Joseph Nason, inventor and founder of the company. Upon the death of his brother-in-law, Carleton W. Nason, in 1906, Dr. Seabrook, who had always specialized in finance as a hobby, was elected president of the company.

WILLIAM L. GLATFELTER, vice-president and director of the York Ice Machinery Corporation, York, Pa., died on April 21 at Pinehurst, N. C. A resident of Spring Grove, Pa., Mr. Glatfelter was president of the York Manufacturing Company before its merger with the York Ice Machinery Corporation in 1927. He was also president of the P. H. Glatfelter Paper Company of Spring Grove, Pa.

JAMES VERNIER SCAIFE, president of the William B. Scaife & Sons Company, died on March 31 at Pittsburgh, Pa., according to a recent announcement of the company.

Personals

RALPH A. SHERMAN has been appointed to direct the program of research on combustion at Batelle Memorial Institute of Columbus, Ohio, the Institute announces. For the past ten years Mr. Sherman has been fuel engineer with the Pittsburgh Experiment Station of the United States Bureau of Mines, where he conducted investigations and published numerous reports on combustion problems. For the past several years he had charge of the field investigation of the service conditions of refractories in boiler furnaces, which the Bureau of Mines conducted in cooperation with the Special Research Committee of the A.S.M.E.

H. CRAIG SUTTON, formerly electrical engineer of the United Gas Improvement of Philadelphia, Pa., has been appointed chief engineer of the Cuban Electric Company, Havana, Cuba, a subsidiary of the American & Foreign Power Company.

GEORGE R. ALEXANDER, for seventeen years employed as sales engineer and later sales manager of the Byron Jackson Pump Company of Berkeley, Calif., has been appointed vice-president and Eastern manager of the company, with headquarters in the Graybar Building, New York City. Mr. Alexander will have charge of all of the company's activities east of the Mississippi River and of its export trade.

PAGE GOLSAN, recently vice-president of the Great Western Portland Cement Company of Kansas City, Mo., has just been appointed manager of the new business department of the engineering organization of Ford, Bacon & Davis, New York City. Mr. Golsan was associated with the latter firm for many years before taking up his duties with the cement company.

W. S. RUGG, vice-president in charge of engineering, has been placed in charge of sales activities of the Westinghouse Electric & Manufacturing Company, in addition to engineering activities, according to an announcement by F. A. MERRICK, president. Mr. Rugg, by this appointment, takes over the activities of EDWARD D. KILBURN, vice-president and general sales manager, who resigned recently and whose resignation was accepted by the board of directors on April 16. S. M. KINTNER, director of the Westinghouse Research Laboratory, has been made assistant vice-president, according to Mr. Merrick's announcement, and he assumes engineering department duties under Mr. Rugg's direction.

GEORGE H. WISTING, for several years manager of the industries department of the Portland (Ore.) Chamber of Commerce, has resigned from that position to take the recently created position of industrial engineer with the Northwestern Electric Company, Portland.

With the SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Inspection of Macy's plant, 34th St. and Broadway, New York, on April 30 at 7 p.m. Meeting at 8:15 p.m. in the Engineering Societies Building. Sponsored by the A.S.M.E. Oil and Gas Power Division. Subject: "Diesels in Store Buildings," by George Pogue, Eastern sales manager, Fulton Iron Works Company.

A.S.M.E., St. Joseph Valley Section. Inspection of Twin Branch Super-Power Plant at 4 p.m., May 8. Dinner meeting at 6:30 p.m. Subject: "The Character of Metals as Determined by X-ray Micro Photography," Prof. G. L. Clark, University of Illinois.

N.E.L.A., East Central Division. Annual convention at the Hotel Statler, Cleveland, Ohio, May 20-23. Secretary, D. L. Gaskill, Greenville, Ohio.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Business Notes

THE TEXAS COMPANY announces the removal of its New York offices to 135 East 42nd St., New York City.

READING CHAIN & BLOCK CORPORATION, Reading Pa., has appointed R. G. Elliott, 631 Chapel St., New Haven, Conn., to handle its entire line in the state of Connecticut.

THE CONNERSVILLE BLOWER COMPANY, Connersville, Ind., has moved its Chicago sales office to Room 1428, 20 North Wacker Drive. Also, after May 1, the New York sales office of the company will be located at Room 533 of the Graybar Building, 520 Lexington Avenue.

THE DAMPNEY COMPANY OF AMERICA, Hyde Park, Boston, Mass., announces the opening of a direct company branch office at 305 Thomas Bldg., Dallas, Texas. J. Dwight Bird will be in charge of the Southwestern territory.

BIGELOW-LIPTAK CORPORATION, Detroit, Mich., announces that H. S. Ford, formerly Eastern sales manager of the R. H. Beaumont Company of Philadelphia, Pa., has become associated with it and will be located at its headquarters in Detroit.

FIREBRICK REPAIR & SUPPLY COMPANY has moved to new and larger quarters at 63 Walnut St., Newark, N. J.

THE TIMKEN ROLLER BEARING COMPANY, Canton, Ohio, announces that the following officers were elected at its annual board of directors meeting on April 15: H. H. Timken, chairman; M. T. Lathrop, president; W. R. Timken, J. G. Obermier, J. W. Spray, H. J. Porter, T. V. Buckwalter, L. M. Klinedinst, vice-presidents; R. C. Brower, secretary-treasurer; J. A. Riley, assistant treasurer; F. F. Tudor, assistant secretary.

BYRON JACKSON COMPANY, Berkeley, Calif., announces the completion and occupancy by its deepwell turbine division of a new factory at Berkeley. Modern in every way, the new plant covers an area 70 x 180 ft. This will ultimately be enlarged to 100 x 275 ft.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Apr. 24, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Apr. 17, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.495 per bbl., or 42 gal.; 26@28 deg., $1.595 per bbl.; 28@30 deg., $1.695 per bbl.; 30@32 deg., $1.745 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Apr. 15, f.o.b. local refinery, 30@34 deg., fuel oil, 4.37½c. per gal.; 36@40 deg., 4.37½@4.5c.

Philadelphia—Apr. 15, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati—Apr. 15, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Apr. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Apr. 21, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Apr. 19, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

Trade Catalogs

PUMPS—Bulletin No. 91 of the Decatur Pump Company, Decatur, Ill., contains a general description of Burks super-turbine pumps used in condensation return units. Many illustrations in color show constructional features of these pumps.

CHAIN DRIVES—The Diamond Chain & Manufacturing Company, Indianapolis, Ind., has just published a 44-page, illustrated booklet on sprockets for roller chain drives. Complete mechanical specifications are given for single- and multiple-strand chains for drives rated up to 672 hp. Other information includes recommended heat treatment for sprockets and tables of sizes, ratings and prices.

DRAFT GAGES—Bulletin 12 of the Ellison Draft Gage Company, 214 W. Kinzie St., Chicago, Ill., describes the new dial type pointer draft gage equipped with one, two or three pointers to read minus, plus or differential gasometer bell, beam and pointer type operating on three knife edges. The differential gage uses two bells, one within the other and both on the same side of the fulcrum.

PULVERIZERS—The Fuller Lehigh Company, Fullerton, Pa., announces a new publication, Circular 902, on pulverizing mills. This 4-page illustrated booklet tells in an interesting way the economic and mechanical advantages of the air and screen separation type mills.

CONVEYORS—Bulletin 121 of the Gifford-Wood Company, Hudson, N. Y., fully illustrates and describes the merits and applications of the Gifford-Wood coal pockets, both trolley bucket and chain and bucket.

BURNERS—General specifications, applications, installation and operation of Doreco low-pressure gas and oil burners are described and illustrated in Bulletin No. 2NA recently issued by the National Supply Companies, 3320 Bishop St., Toledo, Ohio.

ALLOYS—The outstanding applications of nickel cast iron are classified under five important industrial fields for ready reference by designing engineers or manufacturers of equipment in a recent booklet, entitled "Notes on Uses of Nickel Cast Iron," published by the International Nickel Company 67 Wall St., New York City.

TURBINES—A fully illustrated description of Murray steam turbines for generating units is contained in Bulletin T 105 recently issued by the Murray Iron Works Company, Burlington, Iowa. Other new publications of the pressures. The movement is of the company include Bulletin T 106 on steam turbines for pumping units and Bulletin T 107 on turbine-gear units for low-speed drives.

BUCKETS—The Hayward Company, 50 Church St., New York City, has just published two bulletins: No. 700 on electric motor clam-shell buckets and No. 654 on Class "K" clam-shell buckets.

METERS—An illustrated folder descriptive of the applications of flow meters in central stations and industrial plants has just been issued by the Brown Instrument Company, Wayne & Roberts Aves., Philadelphia, Pa.

MOTORS—Type AA Reliance induction motors for two- and three-phase alternating-current circuits are described and illustrated in Bulletin No. 106 of the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio. Construction details, applications and installation data are contained in its 15 pages.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fairfield — G. G. Halliday, Co. Clk., will receive bids until May 5 for the construction of a sewage system including pumping plant, etc. Estimated cost $125,000.

Calif., Los Angeles—H. G. Ferguson Corp., 756 South Spring St., awarded contract for the construction of a 13 story office and stores building at 6th and Flower Sts., to R. Millsap, Pacific National Bank Bldg. Estimated cost $1,500,000. Steam heating system, elevators, etc., will be installed.

Calif., Los Angeles—Frank Good & Associates, is having preliminary plans prepared for the construction of a 13 story office and stores building, including steam heating system, high speed elevators, etc., at Figueroa St. between 5th and 6th Sts. Estimated cost $1,500,000. Walker & Eisen, 1117 Western Pacific Bldg., are architects.

Calif., Los Angeles—M. Lombardi & Associates, 139 North Broadway, plans the construction of a 13 story office and stores building, including steam heating system, eight high speed elevators, etc., at First St. and Broadway. Estimated cost $1,500,000. A. Curlett, 1012 Union Bank Bldg., is architect.

Calif., Los Angeles—Serrano Corp., H. DeRoulet Co., plans the construction of a theatre and commercial building, including steam heating system, elevators, etc., at Wilshire Blvd. and Western Ave. Estimated cost $1,000,000. Morgan, Walls & Clements, 1134 Van Nuys Bldg., are architects.

Calif., Mountain View — City, B. L. Hays, Clk., will soon award contract for the installation of a deep well turbine pumping plant.

Calif., San Diego — L. Reich, 434 North Coronado St., Los Angeles, awarded contract for the construction of a 9 story hotel at Point Loma here, to Hart Bros. Construction Co., 3921 West 6th St., Los Angeles. Estimated cost $1,500,000. Steam heating system, elevators, etc., will be installed.

Calif., Whittier—City plans an election to vote $310,000 bonds for extensions and improvements to water system, including wells, pumping plants, reservoirs, etc.

Colo., Rye—L. P. Piper & Associates, c/o Royal Bridge Amusement Co., Canon City, are having preliminary surveys made for the construction of a hydro-electric plant on Greenhorn Creek near here. G. D. Cole, c/o owner, is engineer.

Conn., Hartford—House of Good Shepherd, 170 Sisson St., will soon award contract for the construction of a home, including 45 x 180 ft. industrial building, 42 x 100 and 45 x 150 ft. children's building, and 42 x 64 ft. power house. Estimated cost $400,000. Gander, Gander & Gander, 17 Steuben St., Albany, N. Y., are architects.

Kan., Kansas City—Bd. of Public Utilities, c/o C. Lowder, Secy., awarded contract for a 12,500 kw. turbine generator to Westinghouse Electric & Mfg. Co., 2124 Wyandotte, Kansas City, Mo., $183,550; condenser to Elliot Electric Co., 305 Barnes St., Pittsburgh, Pa., $47,950; boiler to Babcock & Wilcox Engineering Co., Beaver Falls, Pa., $284,800.

Ky., Louisville — Louisville Gas & Electric Co., 311 West Chestnut St., is having plans prepared for the construction of a high tension power line, 40,000 kw., 132,000 v. from Louisville, Ky., to Cincinnati, O., to transmit power generated by hydro-electric plant on Ohio River at Louisville. Three 18,750 kw. transformers will be installed at Louisville plant. Estimated cost $1,000,000. L. S. Streng, V. Pres., in charge of operation.

Mass., Brighton (sta. Boston)—Harvard University, A. L. Lowell, Pres., awarded contract for a 1 story, 75 x 100 ft. power house at Harvard Medical School to Turner Construction Co., 178 Tremont St., Boston.

Mass., Ipswich — Town, H. Walton, Town Hall, is receiving bids for addition to municipal power and lighting plant. Estimated cost $40,000. Fairbanks, Morse & Co., 88 High St., Boston, are engineers.

Mass., Salem — Salem Gas Light Co., 200 Devonshire St., Boston, and 205 Washington St., Salem, plans the construction of a super power station. Estimated cost $40,000. C. H. Tenney Co., 38 Chauncy St., Boston, is engineer.

Mass., Somerville (Boston P. O.) — Continental Baking Co., 259 Lowell St., awarded contract for addition and alterations to boiler house to F. Leroy Fox Co., 101 Milk St., Boston.

Mass., Springfield—United Electric Light Co., 73 State St., awarded contract for the construction of a power substation on Converse St., Forest Park Dist., to E. J. Pinney Inc., 220 Dwight St. Estimated cost $40,000.

Mich., Battle Creek—Old Merchants National Bank & Trust Co., will soon award contract for the construction of an 18 story bank and office building including three elevators and two escalators at 25 Michigan Ave. Estimated cost $1,200,000. Weary & Alford, 1923 Calumet Ave., Chicago, are architects.

Mich., Dearborn—G. I. Dingeman, Wayne County Drainage Comr., Detroit, will receive bids until May 8 for the construction of a pumping plant, etc., in connection with sewage treatment work. J. J. Murphy, 503 Murphy Bldg., Detroit, is engineer.

Mich., Detroit—Dept. of Public Works, City Hall, plans the construction of a 25 story city hall building including steam heating and ventilation systems, boilers, elevators, etc. on Woodward Ave. Estimated cost $3,000,000. Architect selected.

Mich., Jackson — Consumers Power Co., awarded contract for addition to Becker oven by-product coke and gas plant, including eleven producer gas heated Becker ovens, 35,000 ton annual coal capacity and 1,200,000 cu.ft. daily gas capacity, to Koppers Construction Co., Koppers Bldg., Pittsburgh, Pa.

Mo., Concordia—City defeated $30,000 bond election for the construction of a municipal electric light plant. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, Engrs.

Mo., St. Louis—St. Louis Star, E. Roberts, 12th and Olive Sts., awarded contract for the construction of a 5 story, 120 x 168 ft. newspaper publishing plant at High, Morgan and 12th Sts. to Midwest Industrial Development Co., 1221 Locust St. Estimated cost $1,500,000.

N. J., Asbury Park—Bd. of Commissioners, City Hall, awarded contract for a 1 story theatre refrigeration plant to DeRiso Bros., 551 5th Ave., New York, N. Y. Estimated cost $40,000.

N. J., Browns Mills — Deborah Jewish Consumptive Relief Society, M. L. Unger, Chn. Bldg. Comn., 763 Broad St., Newark, will receive bids until May 5 for the construction of a 4 story sanitorium including power plant, service building, etc., here. Estimated cost $1,000,000. F. Grad, 1023 Broad St., Newark, is architect. T. B. Kedner, 175 5th Ave., New York, N. Y., is consulting architect.

N. J., Deal—Long Branch Bd .of Comrs., plans extensions and improvements to pumping stations. Estimated cost $19,500.

N. J., Jersey City—W. Neumann, 26 Journal Sq., Archt., will receive bids until May 1 for the construction of a 9 story office and stores building, including steam heating and ventilation systems, boilers, elevators, etc., at Newark and Oakland Ave., for Spingarn Realty Co., 591 Summit Ave. Estimated cost $750,000.

N. J., Paterson—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a 30 x 40 ft. electric substation at 465-479 River St., to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $40,000.

N. J., Trenton—Guilbert & Betelle, 20 Branford Pl., Newark, Archts., will receive bids until May 6 for the construction of a group of school buildings including 48 x 59 ft. boiler house at Hillwood Lakes for State Bd. of Education.

N. Y., Long Island City—Dept. of Water, Gas & Electricity, New York, plans the construction of a 90 x 95 ft. waterworks pumping station at Nassau Blvd. and Allegheny Pond Rd. Estimated cost $35,000. Private plans.

O., Akron — Main Street Holding Co., T. DeWitt, V. Pres. and Gen. Mgr., c/o Hollenden Hotel, awarded contract for the construction of a 17 story hotel, to Carmichael Construction Co., Central Savings & Trust Bldg. Steam heating system, etc., will be installed.

O., Akron—Young Mens Christian Association, awarded contract for the construction of a 16 story building at Center, Water and State Sts. to Clemmer-Noah Construction Co., 470 East Market St. Estimated cost $1,350,000. Steam heating system, etc. will be installed.

O., Cleveland—Bd. of Education, F. G. Hogen, Dir., will receive bids until May 5, for remodeling heating plant including new steel boilers at Milford School.

O., Cleveland—Bd. of County Commissioners, F. G. Husak, Clk., plans the construction of a detention home including steam heating system, etc. Estimated cost $1,000,000. Architect not selected.

O., Northfield (br. Bedford) — Cleveland Electric Illuminating Co., W. H. Hartman, Purch. Agt., 75 Public Sq., Cleveland, awarded contract for the construction of an electric substation, here, to R. S. Ursprung, Berea. Estimated cost $40,000.

Okla., Freedom—E. W. Baker & Co., Perrine Bldg., Oklahoma City, plans an election May 12 to vote $40,000 bonds for the construction of an electric light and water plant here. Private plans.

Pa., Indiana—Indiana Co. Memorial Hospital, awarded contract for the construction of a 3 story hospital, including power house and laundry to Wilson Construction Co., Johnstown Trust Bldg., Johnstown. Estimated cost $150,000.

Pa., Philadelphia—Philadelphia Electric Co., 10th and Chestnut Sts., awarded contract for the construction of a 62 x 125 ft. substation at Brill and Torresdale Sts., to United Engineering & Construction Co., 112 North Broad St. Estimated cost $122,000.

Pa., Pottstown—Hill School, J. Wendell, Head Master, plans the construction of a science laboratory, power plant and gymnasium. Estimated cost $800,000. C. Z. Klunder, 1429 Walnut St., Philadelphia, is architect.

Tex., Houston—City, c/o W. E. Monteith, Mayor, is having plans prepared for the construction of substation, also wells, etc. in connection with waterworks. Estimated cost $438,000. C. R. Haile is city engineer.

Tex., San Antonio—Scobey Fireproof Storage Co., 311 North Medina St., is receiving bids for the construction of a cold storage warehouse at 300 Blk. North Medina St. Estimated cost $250,000. Engineering Service Corp., 1806 Post-Dispatch Bldg., Houston, is engineer.

Tex., San Antonio—Southwestern Bell Telephone Co., Telephone Bldg., St. Louis, Mo., awarded contract for the construction of an 8 story administration and equipment building at Auditorium and Martin St., to McKenzie Construction Co., Travis Bldg. Estimated cost $2,000,000. Steam heating system, etc., will be installed.

Tex., Woodsboro — Central Power & Light Co., Frost Bldg., San Antonio, awarded contract for the construction of a 40 ton ice plant here to Sumner Sollitt Co., 609 Frost Bldg., San Antonio. Estimated cost $32,000.

Wash., Tacoma—City received lowest bid for construction and materials for intake structure for municipal steam plant No. 2 from Coast Contractors, 1624 South Tacoma St. $26,529.

Wis., Eau Claire—City is having plans prepared for improvements to waterworks including filtration and pumping plant, etc. Estimated cost $200,000. Alvord, Burdick & Howson, 6 South Dearborn St., Chicago, Ill., are engineers.

Ont., Brantford—City, R. L. Beckett, Mayor, will receive bids until May 9 for the construction of a filtration plant, pumping station, reservoir, etc. Estimated total cost $250,000. F. P. Adams, City Hall, is city engineer. W. S. Lea, 1226 University Ave., Montreal, Que., is consulting engineer.

Ont., Hamilton—Medical Arts Association, L. C. Mulligan, Mgr., 136 Main St. E., awarded contract for the construction of a 7 story, bank, office and stores building on James St. to W. H. Cooper, 42 James St. N. Estimated cost $500,000. Steam heating system, etc. will be installed.

Ont., Niagara Falls—City will receive bids about May 1 for the construction of a filtration plant and pumping station in connection with waterworks. Estimated cost $500,000. W. S. Orr is city engineer.

Ont., Orillea—Town will build a sewage pumping station, sub sewage pumping station, etc., in connection with sewage treatment work. Estimated total cost $61,787. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers. Work will be done by day labor.

Ont., Ottawa—Minto Skating Club, L. H. Hill, Walker St., plans the installation of a plant for provision of artificial ice at rink.

Ont., Peterborough — City will receive bids until April 30 for the construction of a boiler house, etc., for addition to sewage disposal plant. Estimated cost $75,000. R. H. Parsons, City Bldgs., is engineer.

Ont., Toronto — Toronto Electric Commissioners, 225 Yonge St., awarded contract for the construction of a 2 story electric substation, to Witchall & Son, 156 St. Helens Ave. Estimated cost $600,000.

Que., Outremont—City will soon receive bids for the construction of a new transformer station. Estimated cost $25,000.

Sask., Regina — City will soon receive bids for extensions to power plant, light distribution system, substations, etc. Estimated total cost $656,000.

Mexico, Monterrey — Inversiones Monterrey Inc., c/o M. Elizondo, is having plans prepared for the construction of a 10 story hotel, incuding steam heating, ventilation and refrigeration systems, boilers, elevators, etc. Estimated cost $900,000. H. S. Green, c/o Alamo National Bank Bldg., San Antonio, Tex., is architect.

Equipment Wanted

Generator—Annandale, N. J.—Dept. of Institutes & Agencies, State Office Bldg., Trenton, will receive bids until May 1 for furnishing and installing a generator at New Jersey Reformatory here.

Generators—New York, N. Y.—New York Edison Co., M. S. Sloan, Pres., 4 Irving Pl., are receiving bids for two new turbo generators, 160,000 kw. capacity each for Hudson Ave. station of Brooklyn Edison Co.

Pump—Ventura, Calif.—County Supervisors, will receive bids until May 6 for furnishing and installing booster pump, etc., for proposed waterworks.

Pump—Puente, Calif.—Los-Neitos-La Puente Valley County Water Dist., will receive bids until May 13 for furnishing and installing a deep well turbine pump, 175 in. in connection with waterworks.

Pumping Equipment — Vanceburg, Ky. — Pumping equipment, etc., for proposed waterworks system.

Pumping Unit—Mission, Tex.—Santa Maria Water Control & Improvement Dist., plans the installation of a pumping unit in connection with proposed irrigation project. Estimated cost $50,000.

Pumping Units—Cumberland, R. I.—Bd. of Water Commissioners, Town Hall, will receive bids until May 2 for two complete pumping units for proposed waterworks improvements.

Switchboards, Generators, Transformers, etc. —New Orleans, La.—Sewerage & Water Board, switchboards, motor generators, transformers, controls, etc., for drainage station No. 3 and 7, Cont. 117-D.

Turbines and Generating Sets — Wellington, N. Z.—Dept. of Public Works, Supplies & Tenders Committee, will receive bids until July 29 for auxiliary turbines and generating sets for Arapuni power scheme.

Industrial Projects

Conn., New Haven—B. Rottman, c/o H. S. Cannici, 185 Church St., Archt., is receiving bids for a 2 story, 30 x 125 ft. factory for the manufacture of mattresses on Chapel St. Estimated cost $42,000.

Ill., Chicago—Aridor Co., 589 East Illinois St., is having plans prepared for the construction of a 2 story, 132 x 350 ft. factory for the manufacture of caps for glass containers, etc., at 3428-40 West 48th Pl. Estimated cost $125,000. A. Epstein, 2001 West Pershing Rd., is architect.

Ind., Anderson—Guide Lamp Co., plans the construction of a 1 story, 200 x 520 ft. factory at Arrow Ave. and Belt R.R. Estimated cost $70,000. Work will be done under General Motors supervision.

Ind., Elkhart — Time-O-Stat Co., awarded contract for the construction of a 60 x 250 ft. factory on McNaughton Ave. to George C. Kistner, Elkhart. Estimated cost $46,200.

Mass., Everett—New England Fuel & Transportation Co., Rover St., awarded contract for the construction of a coke oven, crusher bin and blower house; storage building and gas producer unit to Koppers Construction Co., Rover St. Total estimated cost $140,000.

Mo., Crystal City — Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa., will soon award contract for addition to glass plant here. Estimated cost $1,000,000.

Mo., St. Louis—F. M. Stambaugh & Sons, Inc., 4356-58 Maffitt Ave. (toolmakers), awarded contract for a 1 story, 100 x 132 ft. factory at Sacramento St. near Kingshighway to F. F. Meckfessel Construction Co., 6625 Delmar St., St. Louis.

N. J., Bloomfield — General Electric Co., Lawrence St., awarded contract for the construction of factory No. 12, 1 story, 45 x 135 ft., on Lawrence St., to Becker Construction Co., 361 Grove St., Newark. Estimated cost $40,000.

N. Y., Buffalo—W. Simons Estate, Liberty Bank Bldg., awarded contract for the construction of a 1 story, 100 x 220 ft. factory at 1320 Main St. to F. C. Kempf, 821 Virginia St. Estimated cost $50,000. General Motors Parts Dept., General Motors Bldg., Detroit, Mich., lessee.

O., Canton — Union Metal Mfg. Co., 1432 Maple Ave. N. E., plans the construction of a 1 story, 46 x 240 ft. factory for the manufacture of metal lighting standards. Estimated cost $40,000. Private plans.

O., Cleveland—Allied Oil Co., F. R. Newman, Secy. and Treas., 1021 Guardian Bldg., is having plans prepared for the construction of a group of buildings, including boiler house, pump house, oil storage building, etc., at East 40th St. and Lakeside Ave. Estimated cost $250,000. Private plans.

O., Cleveland—American Steel & Wire Co., J. S. Keefe, Pres., Rockefeller Bldg., is having plans prepared for the construction of a 1 story, 80 x 700 ft. factory for the manufacture of automobile fenders, metal furniture and tubing for metal beds at East 42nd St. and Harvard Ave. Estimated cost $400,000. Private plans.

Ore., Portland—Montague Stove & Furnace Works, R. T. Montague, Pres., 101 West Columbia Blvd., plans the construction of a 2 story, 60 x 150 ft. enameling plant. Estimated cost $150,000. Architect and engineer not selected. Machinery and equipment will be required.

Pa., Homestead—Universal Atlas Cement Co., 208 La Salle St., Chicago, Ill., is receiving bids for the construction of a 1 story, 16 x 40 ft. cement bulk warehouse, including bulk unloading building, six tanks 50 ft. high and 24 ft. in diameter, loading platform 50 x 8, etc., at West St. and Second Ave., here. Private plans.

Pa., Meadville—Hookless Fastener Co., East Arch St., awarded contract for a 3 story, 50 x 70 ft. factory, to G. Rutherford Co., 2725 Prospect Ave., Cleveland, O.

Ont., Brampton — G. M. Miller & Co., 71 Mutual St., Toronto, Archts., are receiving bids for the construction of a 1 story, 80 x 350 ft. factory for the manufacture of pianos, piano keys, etc., here, for Otto-Higel Co. Ltd., 680 King St. W., Toronto. Estimated cost $75,000.

Ont., Creighton Mines — International Nickel Co. of Canada, Copper Cliff, awarded contract for the construction of a plant and crusher house here, to Fraser Brace Ltd., Coppercliff. Estimated cost $125,000.

Ont., Hamilton—B. Greening Wire Co., Queen St. N., is having plans prepared for the construction of a 4 story, 70 x 112 ft. addition to factory. Estimated cost $60,000. B. H. Prack, 36 James St. S., is architect. Machinery and equipment will be required.

Que., Montreal—Canadian Copper Refineries Ltd. and Nichols Copper Co., Washington St., Long Island City, N. Y., plan the construction of copper refinery here. Estimated cost $2,000,000. Equipment will be required.